SPECIFICATION FOR A

HOST COMPUTER DIGITAL SIGNAL PROCESSING SYSTEM FOR COMMUNICATING OVER VOICE-GRADE TELEPHONE CHANNELS

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FIELD OF THE INVENTION

This invention relates to electronic communications systems and more particularly to a system for enabling a computer to transmit and receive information over an analog communications link.

BACKGROUND OF THE INVENTION

Computers typically use modems to communicate digital information over voice-grade telephone lines. Such modems translate digitally expressed information from the computer into analog tone signals suitable for transmission over the voice-grade telephone facility, and convert such tones back into digital form when received from the telephone line.

High speed modems may advantageously employ digital signal processing techniques for translating outgoing digital data into a sequence of digital values each representing a desired analog output signal sample amplitude. These digital sample values may then be converted into analog form by a digital-to-analog converter for transmission over the telephone facility. Correspondingly, at the receiving station, the incoming analog signal may be converted into a train of digital sample amplitude values which are then processed to reconstruct the original digital data.

The processing of the digital sample values is complex and has heretofor been accomplished by one or more dedicated microprocessors which form the heart of the digital modem. For example, the 9600 baud HST modem manufactured by U.S. Rob tics C rporati n and described in U.S. Patent 5,008,091 issued on April 16, 1991 employs three microprocessors: (1) a transmitting

microprocessor dedicated primarily to the translation of digital data into digital sample values; (2) a receiving microprocessor devoted primarily to the translation f sample amplitude values back into digital data; and (3) a supervisory microprocessor which serves as the interface to the computer to which the modem is connected.

SUMMARY OF THE INVENTION

The present invention, like the digital modems described above, employs analog/digital conversion methods to convert received analog signals into digitally expressed analog sample values and, during transmission, to convert digitally expressed sample values into analog form. Unlike prior digital modems, however, in the present invention the digital sample value signals are not processed by a separate processor or processors within the modem unit, but are rather processed by the microprocessor already present in the connected computer. As a consequence, the cost of the modem is substantially reduced because the need for separate processors is eliminated.

The arrangement contemplated by the invention is implemented by the combination of a conventional host computer employing a microprocessor and a low-cost interface unit consisting of telephone line adaptor circuitry, an analog/digital converter, and a direct digital interface to the host computer's system I/O bus. The telephone interface unit exchanges digitally-expressed analog sample amplitude values directly with the connected host computer, and the microprocessor within the host computer handles the remainder of the digital processing.

When operating as a modem, digital data can be processed into a sequence of digitally expressed sample values in accordance with a selected one of several accepted modem formats and transmission speeds. Given processors of speeds typically available, such modem processing can take place in real time to eliminate the need for storing the digital sample data in memory; for example, using the preferred embodiment of the invention to be described, a relatively slow Intel 80286 (IBM-AT class) processor operating at 12 mhertz

has been shown to have adequate computational capability to perform the modulation and demodulation processing needed for 2400 baud full-duplex modem peration.

Without requiring any additional hardware, the system may be programmed to send and receive graphical data as standard V.29 format facsimile data, or to send and receive data synchronously operating, for example, as an IBM 3270 compatible terminal device. Moreover, when the digital sample values represent conventional voice transmissions rather than data, the system may be used to provide automated voice recording and playback functions to implement a telephone answering, voice message handling, and telemarketing systems.

These and other functions may be added or revised without requiring any hardware modifications by simply changing standard programs which execute on the host processor in standard ways.

These and other features and advantages of the present invention will become more apparent by considering the following detailed description of a preferred embodiment of the invention. In the course of this description, reference will frequently be made to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates the major hardware components of the preferred embodiment of the invention;

Figure 2 is a block diagram of the major components of the interface card; and

Figure 3 is a detailed block diagram of the interface card; and

Figure 4 is a functional block diagram illustrating the interaction of the major functions implemented by the host processor under program control.

DETAILED DESCRIPTION

The preferred embodiment of the invention as illustrated in Figure 1 consists of auxiliary components mounted on an expansion card 15 which plugs into an available socket 17 on the motherboard 19 f a conventi nal IBM-

compatible Personal Computer indicated generally at 20. The host computer 20 includes a conventional single-chip integrated microprocessor 22 which executes pr grams stored in a RAM memory unit which is depicted in Fig.1 as a group of SIMM (single inline memory module) devices 24 mounted on the motherboard 19. The RAM memory 24 is typically loaded with programs to be executed by the microprocessor 22 from their permanent storage location on a magnetic disk drive (not shown). The programs described which will be described below in connection with this preferred embodiment of the inventi n are executable on any IBM-compatible personal computer using the MS-DOS operating system. In order to provide adequate computational capacity, the microprocessor 22 is preferably be selected from the Intel 80286, Intel386 or Intel486 families of processors, or their functional equivalents, and should operate at a clock rate of at least 12 megahertz. In the description to follow, reference will also be made to the host computer's standard DMA (direct memory access) controller seen at 26 in Fig. 1. The host computer 20 includes an internal system bus 28 which interconnects the microprocessor 22, the random access memory 24, the DMA controller 26 and the expansion card 15 via the expansion socket 17.

As seen in both Figs. 1 and 2, the expansion card 15 is provided with a standard telephone jack 29 through which a connection is made to a conventional voice-grade telephone line 30. The major components included on the interface card 15 are seen Fig 2. The card 15 takes the form of a standard "half-size adapter card" which plugs into an available expansion slot 17 on the host computer 20 to connect to the host computer's internal bus 28. Detailed information on the structure and operation of the interface bus 28, as well as other aspects of the personal computer system 20, may be found in the applicable *IBM Technical Reference Manual*, IBM Corporation, Boca Raton, FL 33432. Details concerning the Intel family of microprocessors and their companion DMA controllers appears in the *Intel Microprocessor and Peripheral Handbook* (1990), Intel Corporation, Santa Clara, CA.

The interface card sends and receives analog signals over a voice-grade analog telephone line which is connected at the terminal 29. Two standard RJ11 telephone jacks (not show) may be used to provide convenient external connections to standard telephone equipment, one jack accepting a plug from the telephone line and the second a plug from a telephone station set which may share use of the line.

As seen in Fig. 2, the interface card includes a line adaptor circuit interconnects the telephone terminal 29 with a hybrid circuit which splits the analog voice-band signal into inbound and outbound components which are respectively sent to and received from the analog ports of an analog / digital converter 40 (also called the "AIC" or "analog interface chip"). Converter 40 samples received voice-band signals, encodes the sample amplitudes into digitally-expressed values, and sends these values via bus interface circuitry seen at 45 in Fig. 2 to the host computer 20. As described in more detail below, the conventional processor within the host computer 20 processes incoming digitally-expressed sample values to perform one of a variety of functions, depending on the nature of the incoming signal.

Outbound communications originate within the host computer 20 which processes the information to be sent to create a sequence of digitally-expressed sample amplitude values which are sent via the interface circuitry to the converter 40 which transforms the digital sample values into the corresponding voice band analog signal which is applied via the hybrid circuit 35 and the line adapter 31 to the telephone line connected to terminal 29.

SIGNAL RECEPTION

The processing of the incoming voice-grade signal in the interface card is shown in more detail in Fig. 3. The incoming voice-band signal arriving at terminals 31 seen in Fig. 3 may be a conventional telephone voice signal, a modulated-tone data signal from a modem, a facsimile signal, or some other signal capable of being transmitted over conventional telephone links.

Regardless of their content, incoming and outgoing signals are processed in the same way by the interface card 15.

Arriving signals from the telephone link are applied directly via a transformer 33 to the input of an amplifier 35A within a hybrid network 35. The signal appearing at the output of amplifier 35A is applied to the analog input terminal 37 of a two-way analog/digital converter 40. The hybrid network 35 is of conventional design and includes a transmit amplifier 35B which is interconnected with the input to amplifier 35A by means of a resistive network which is arranged such that the transmitted signal from amplifier 35B is greatly reduced in magnitude at the output of the receiving amplifier 35A.

The converter 40 preferably takes the form of a single integrated circuit device comprising a Model TLC32044 voice band analog interface unit manufactured by Texas Instruments, Dallas, Texas. Detailed information on the structure and operation of the TLC32044 is contained in Data Sheet D3098 (1988) available from Texas Instruments. The TLC32044 integrates an input analog bandpass filter, an analog-to-digital converter including a sample-and-hold circuit and a successive-approximation encoder which converts the input analog signal on line 37 into a 14-bit resolution digital signal. For processing outbound signals, the TLC320444 includes a 14-bit resolution digital-to-analog converter and a low-pass output reconstruction filter.

The incoming analog signal is applied via line 37 seen in Fig. 3 to the converter 40 and the resulting digitally-expressed sample values are delivered via a bit-serial line 41 into an incoming-data shift register 43. When the converter 40 completes the encoding of a sample of the incoming telephone signal, the shift register 43 holds a 16-bit binary word whose 14 most significant bits specify the amplitude of a sample. The value accumulated in shift register 43 is then transmitted via a data bus 29 to the data port pins of the computer's interface bus 28 during a DMA memory transfer peration as next described.

The analog/digital converter 40 is timed by a clock signal from a clock generator 44 seen in Figure 3. When the c nverter has delivered the last (least significant) bit via its bit-serial output 41, an EODR (end of data received) output 45 from converter 40 activated to inform a control unit 50 that the data in the incoming shift register 43 is ready for transmission. Control unit 50 then issues a direct memory access request signal which is transmitted to the interface bus 28 via a control line in the group of control lines depicted in Figure 1 at 47.

The interface card 15 preferably makes use of two separate DMA channels which are available in IBM-compatible Personal Computers for use by external devices. The receive channel, which moves incoming information via the shift register 43, is activated by a request to DMA channel 6 (DREQ6 at pin D13 on the standard IBM system bus 28). The DMA controller 26 within the personal computer 20 responds with a DMA acknowledge signal which is returned to the control unit 50 via one of the control lines 47 (connected to receive the signal DACK6 at pin D12 on the system bus 28). The control unit 50 responds to the DMA acknowledgement by gating the information from shift register 43 to the computer interface bus 28 via the data bus lines 29.

SIGNAL TRANSMISSION

The analog output signal to be transmitted over the phone line is generated by the analog/digital converter 40 which receives digital words, each comprising a 14-bit sample amplitude value and two control bits, from the I/O interface bus 28 via the bus lines 29, an output latch register 54, and an outgoing-data shift register 56. The latch register 54 holds one digital sample while the sample previously received from the bus 28 is being sent, one bit at a time, from the shift register 56 to the analog/digital converter 40 via the bit-serial line 58.

The transfer of information between the bus 28 and the output latch register 54 is also accomplished by means of a DMA transfer. In this case, when the anal g/digital c nverter completes the conversion f a word from the

shift register 56, it issues an EODX (end of data transmit) signal on line 59 to the control unit 50 which in turn issues a transfer request to DMA channel 5 by activating one of the lines in the control bus 47 (signal DREQ5 applied to pin D11 of the interface slot to bus 28). The DMA controller 26 acknowledges that it is ready to handle the request by activating another of the control lines 47 (signal DACK5 at pin D10 of the interface slot). The control unit responds by transferring the contents of output latch 54 into shift register 56, and by enabling the output latch 54 to receive the data from interface bus 28 via the data bus 29.

The bit-serial data applied to converter 40 via line 58 is converted into an analog signal appearing at analog output 60 of the converter 40. The analog output signal on line 60 is then transmitted by the hybrid amplifier 35B and the transformer 33 to the tip and ring terminals 31 of the connected telephone line.

SUPERVISORY CONTROL

The microprocessor 22 within the personal computer 20 is directly connected via the interface bus 28 to the interface card 15 and provides general supervisory control over its operation. To accomplish this, the EODR signal on output 45 (one of which appears each time the translation of an incoming analog sample is completed) is applied to increment a 4-stage counter 70 which issues an output interrupt signal on line 72 for each group of 16 incoming words. The interrupt signal on line 17 is applied to a selected one of the available interrupt request lines on the interface bus 28 (the particular line IRQ3 to IRQ7 at interface slot pins B21-B25 may be jumper-selected at the time of installation to avoid conflicts with other peripherals issuing interrupts).

When data is being sent or received over the telephone line 30, control of the execution of microprocessor 22 is passed to an interrupt handling routine resident in the memory 24. This single routine, the details of which are set forth in the accompanying assembly language listing f r the INTS

module, calls routines for handling both transmission and reception in accordance with the currently selected mode of operation. These interrupt handling routines process incoming data words from incoming data shift register 43 as those incoming words are assembled in a RAM storage area by the DMA transfer mechanism described above. Secondly, the interrupt handling routines process outgoing information, assemble the outgoing data words indicative of analog sample amplitudes in a RAM storage area pending the DMA transfers to the output latch 54. Note that the single interrupt from line 72, issued on every 16th received word, triggers the handling of the received data being accumulated in the DMA buffer as well as the assembly, in the transmit DMA buffer, of the outgoing data to be converted into analog sample values.

In addition, the microprocessor has access at any time to information about the status of the telephone line, and may send control commands to the interface unit 30 to control that unit's operation. The control lines 47 which exchange control information between the control unit 50 and the interface bus 28 include address lines (at interface slot pins A22-A29 to bus 28) which must contain a particular pattern of bits (in the range 35C to 35F, hexadecimal) designating information to or from the interface unit. When the appropriate address is detected, data from the interface port is placed in the board control latch register 74 to control the line. One bit position of latch 74 may be advantageously used to control an electronic off-hook switch seen at 75 in Figure 1 (which is closed or placed "off hook" to connect the interface unit to the telephone line). A second bit position in the control latch register 74 may be used to connect a speaker 76 to the output of the amplifier 35A by activating a switch 77. A third bit position may be used to reset the AIC 40.

Correspondingly, a sense latch register 80 includes bit positions which are set by the status of the telephone line. A first bit is set whenever a ringing signal detector 82 connected across the telephone line terminals 31 detects the presence of ringing signals of a predetermined amplitude. A loop

current signal detector seen at 84 sets a second bit whenever loop current exceeding a predetermined value is present, indicating an active connection to another system. These status signals may be obtained at any time by a programmed inquiry which places the appropriate I/O address on the address leads within control bus 47.

PROGRAMMING OVERVIEW

In the preferred embodiment of the invention, all digital processing f the digitally-expressed analog sample values which are supplied by and delivered to the interface card 15 are processed by the microprocessor in the host computer. Similarly, the digital information which specifies the telephone line status, as well as control information which takes the telephone line on and off hook, is handled by the host microprocessor. As a consequence, substantially any communication and communication control function using a voice-band channel may be implemented with the hardware disclosed above (and nothing more) by providing appropriate programming for the host computer 20.

The program listing presented at the conclusion of this specification provides numerous functions which allow the combination of the host computer and the interface card to support a rich assortment of voice and data communications applications. The listed source programs are written in conventional assembly language and may be assembled, linked and executed on any IBM-compatible Personal Computer which has sufficient operating speed and which is equipped with the expansion card described above. The assembly language which defines the program and data structures needed to implement the illustrative embodiment is divided into 12 separately listed modules which are summarized below and depicted in Fig. 4 of the drawings:

MAIN.ASM	The MAIN.ASM module seen at 101 in Fig. 4 initializes the interface card hardware and the screen, transmit and receive buffers in the host computer's RAM memory. It displays the main menu by calling the screen handling routines in SCRN.ASM and WIN.ASM as seen at 103 and decodes any user

keystrokes which control the system's operation. In addition, it provides routines capable of answering the phone, recording and playing back voice messages to and from standard DOS disk files as indicated at 104, as well as routines that manage the system when it is operating as a data terminal when keystroke data are directly transmitted and received (via modem processing) over the telephone link.

INTS.ASM This module indicated at 105 handles the interrupts generated by the interface card each time 16 incoming digital samples have been accumulated in the host computers RAM memory by prior DMA transfers as determined by the counter 70 seen in Fig. 3. The interrupt handler calls routines for handling data transmission and reception. In addition, INT.ASM responds to telephone ringing signals generated by detector 82 and line current indications from loop current detector 84 on the interface card 15 as seen in Figs. 3 and 4.

RECVFIL.ASM This module, seen at 107 in Fig. 4, contains the filtering routines used to pre-process the incoming analog signal samples which are received via the incoming DMA channel seen at 108 in Fig. 4. When the system is operating as a 1200/2400 baud modem, the RECVFIL.ASM routines 107 process the accumulated digitally expressed sample values from the interface card and performs band-splitting and phase-splitting digital filtering to create filtered samples for demodulation, as well as automatic gain control and baud rate synchronization.

DEMOD.ASM This module, shown at 109 in Fig. 4, demodulates the filtered sample value from RECVFIL.ASM into data.

DBOX.ASM The DBOX.ASM module at 111 provides routines which allow the host computer's screen to provid an scilloscope-like eye-

diagram display useful for monitoring the performance of the system during modem data reception.

TX.ASM This module, seen at 113, modulates digital data to be transmitted into sample amplitudes which are placed into the transmit buffer from which they are moved via the outgoing DMA channel seen at 114 to the interface card for digital-to-analog conversion into a voice-band analog modem output signal which is transmitted over the phone line. TX.ASM also provides digital filtering to confine the transmitted analog signal to its assigned passband.

TONES.ASM This module, indicated at 115, generates touch-tones and answer tones used by the system to perform conventional dial-up telephone signalling.

CALLP.ASM The call progress monitoring and control module seen at 117 provides supervisory control of the telephone link. It performs band-pass filtering of the receive samples from the interface card in order to detect ringing signals, answer tones, and touch-tone signals, and uses the tone generating routines in TONES.ASM at 115 to produce comparable outgoing tones.

WIN.ASM This module, indicated at 103 along with SCRN.ASM, manages the pop-up windows which appear on the host computer's screen as part of the user interface. This module employs pre-generated character definitions which are specified in the separately listed include file SFT_WINS.INC.

SCRN.ASM This module provides screen management routines used when the system is operating in terminal mode.

EQUATES This module defines commonly used numbers and keycodes referred to in the other modules.

The MAIN.ASM module initializes the system and provides the primary user interface. In the discussion of MAIN.ASM and the other modules which f llows, unless otherwise n ted, the r utines being discussed will be identified by

their labels and may be f und within the listing for the particular module being described.

When the system is started (typically by the entry f the program's name at the operating system's standard command prompt), it is loaded for execution from disk, and execution begins at the label SOFT_MODEM. The amount of memory allocated to the program is reduced to the size of the program plus the size of the stack, and the routine ALLOCATE_BUFFERS is used to create 8k (16-bit word) memory buffers for the both the transmitted and received sample amplitude values. The video display is then initialized and the routines INIT_AIC and INIT_DMA are called to initialize the TLC32044 analog interface circuit 40 on the interface card 15, and to initialize both the transmit and receive DMA channels. A call is then made to the routine WEDGE_INT (listed in INT.ASM) which hooks into the COM2 interrupt (reconfigurable as COM1 through COM4).

A check is then made to determine if the user supplied the name of a voice-recording file to be played back along with the program name when the program was called at the DOS command line. If so, the routine PLAYBACK_MSG (to be discussed) is called immediately, with control thereafter being passed to MAIN_EXIT to terminate the program. In this way, the program can be loaded to play back a recorded voice message without invoking any other functions.

If no recorded message file was specified, ON_HOOK and SPEAKER_OFF are called to insure that hook switch 85 and speaker switch 77 on interface card 15 are both open, and the routine MAIN_SCREEN is begun. The routine INIT_SCREEN (in WIN.ASM) clears the screen and pops up a window for the main menu. The routine at GET_KEY monitors keyboard input and incoming ringing signals.

If ringing signals are detected, the routine ANSWERING_MACHINE is called to take the telephone line off-hook and then call the routine PLAYBACK_MSG to play back a pre-recorded voice message. The routine PLAYBACK_MSG moves the contents of a disk file, which is a sequential file of digitally-expressed voice sample amplitudes, int the transmit buffer, with each transfer being

followed by a call to TX_DMA_ON which enables a DMA transfer of the transmit buffer's contents for digital-to-analog conversion by the interface card 15. To c nserve disk space, the file of digitally-expressed voice samples may be compressed prior to storage and decompressed prior to playback. After the recorded voice message is played for the caller, SEND_TONES (in TONES.ASM) sends a prompting tone to advise the caller that recording is starting.

The ANSWERING_MACHINE routine then calls RECORD_MSG to record the incoming message. A DOS file is opened to record the message, the routine INIT_AIC is called to ready the analog interface circuit 40 to receive at 9600 samples/second, and the incoming samples from the interface board are moved by DMA transfer to the receive buffer from which they are recorded on disk, in 4 kilobyte blocks, in a standard DOS file.

MAIN MENU FUNCTIONS

The routine in MAIN.ASM beginning at MENU_COMMAND processes user keystrokes to invoke functions selected by the user from the following available options which demonstrate the system's capabilities:

KEY	OPERATION
F1	Go to data mode by calling ORIGINATE_MODE_INIT followed by COMM_MODE, which takes keystrokes entered by the user and sends them to the transmitter (to be discussed), and looks for characters from the receiver and puts them on the screen. When operating in terminal mode, the user can press the F2 key to enter the display box mode by calling INIT_DBOX (in DBOX.ASM) in which case the received characters are buffered and keystrokes are processed through the display box menu.
F2	Record voice off the telephone line by calling RECORD_MSG discussed above.
F3	Play back a recorded voice message by calling PLAYBACK_MSG discussed ab ve.

F4 Send an answer tone over the phone line by calling SEND_TONES (listed in TONES.ASM) as discussed above.

F5 Perform ORIGINATE_MODE by dialing a phone number (using DIAL in TONES.ASM) and, if answered, attempts to establish a modem link (using CALLP_MAIN in CALLP.ASM which initiates the expansion card and enables the receiving DMA transfers) in 1200 baud originate mode (by calling INIT_RECV in DEMOD.ASM), and then calls COMM_MODE to perform communications with the remote modem.

F6 Execute call progress functions by calling CALLP_MAIN (listed in CALLP.ASM).

F7 Execute tone detection by calling TOUCH_TONE_DETECT (listed in CALLP.ASM).

F8 Execute automated voice message handling by calling MESSAGING_SYSTEM. This routine uses DTMF (listed in TONES.ASM) to produce the dual dial tones for each digit to be dialed in a number taken from a list of numbers to be dialed. MESSAGING_SYSTEM plays back a message asking the person who answers the remote phone to press the touchtone "1" key on their stationset, then waits to accept the response, at which time MESSAGING_SYSTEM plays back a prompting message and then records the called party's response using PLAYBACK_MSG and RECORD_MSG, and then terminates the conversation by calling ON_HOOK.

Alt-H Toggle between on/hook and off/hook using CHK_ON_OFF_HOOK.

Alt-S Toggle the speaker between on and off conditions using CHK_SPKR.

Alt-P Change parity by calling NEW_PARITY.

Alt-A Toggle answering machine enabled/disabled states using CHK_ANSWER_MODE.

F10 Exit the program and return control to DOS after calling DISABLE_INT (listed in INTS.ASM) to restore the original COM2 interrupt vector and disabling DMA transmission and reception.

SCREEN HANDLING ROUTINES

As seen in the listing WIN.ASM, the routine FILL_SCREEN fills the screen with a background color, WINDOW_UP moves a previously stored window image from a screen buffer to the active screen, and WINDOW_FLIP swaps the active screen memory with the contents of a screen buffer.

The screen is initialized for the terminal mode by a call to INIT_COMM_SCREEN (listed in SCRN.ASM) which is called when data mode is entered. This routine paints the screen blue by calling INIT_SCREEN (in WIN.ASM), which in turn calls WINDOW_UP, brings up data mode windows which indicate speed and parity, and then saves the written screen to a screen buffer for later use.

SCREEN_OUT (listed in SCRN.ASM) performs the terminal mode functions. After checking for special characters, received characters are displayed on the screen. Special characters are the line feed, carriage return and backspace characters, which are handled by the appropriate display-point repositioning functions. If the cursor is on the last line of the screen, a line feed or carriage return character causes the screen lines to scroll upwards. The routine PRINT_PARITY listed in SCRN.ASM is called to place the currently active parity and word length indications on the screen.

The display box mode is entered by calling INIT_DBOX listed in DBOX.ASM. INIT_DBOX calls routines which draw an oscilloscope face on the screen along with a menu of display box options (DBOX_MENU) and initializes the video controller to enable modification of all video planes. The display box may have up to eight points on the screen (POINT0 - POINT7) each of which is defined by a data structure of type SCOPE_POINT. The routine PLOT_POINT places yellow dots on the screen using the publicly declared horizontal and vertical coordinates X and Y. Each dot displayed consists of three lines of dots. RESTORE_OLD removes the yellow pixels and replaces them with either light gray, dark gray or blue, depending on whether the pixel is positioned on the blue background of a reference line. DO_COLOR reads the old point out of the data structure and is called three times, nce for each c l r. SAVE_COLOR saves the bits is als performed once for each col r and saves the bits where

the new dots will go. GET_COLOR reads the video RAM and checks for an intersection between a new oscilloscope dot and the desired color. The eye diagram of the incoming signal is produced by the demodulation routine DEMOD in DEMOD.ASM which, at the label DISPLAY_BOX, sets the variables X and Y and calls PLOT_POINT.

CALL PROGRESS MONITORING

The routines for monitoring and controlling the telephone circuit connected to the interface card 15 are listed in CALLP.ASM which begins by defining various coefficients and delay line values used by the call progress filters.

The routine CALLP_FILTERS executes a filtering algorithm for each input sample value in the received sample buffer, and calculates a mean square output level value for each filter. As indicated by the comment lines in the assembly language listing, the DC component is first removed from the sample value, and the input sample is then processed by the ANSWER_TONE_FILTER routine, at the end of which a check is made to determine if the system is currently waiting for the answer tone to end (which occurs during the originate mode training sequence to be described). The voice filtering algorithm may then performed to obtain a means square voice level indication (in the CALLP.ASM listing, the voice filter algorithm has been commented out to reduce runtime, but is retained here for illustration). Next, the call progress filtering routine is performed to detect dial tones, busy tones, and ringing signals. The mean square level (power level) output from each filter is transferred into a holding location for CALLP_MAIN to test later whenever SAMPLE_COUNT is decremented to zero.

The DTMF_FILTERS algorithm performs basically the same function as the call progress filters described above, except that the dual tones are written. In this illustrative embodiment, a filter for the touch-tones for "1" only are present, and the detecti n of a received "1" tone is used in the example v ice

message handling system implemented by the routine MESSAGING_SYSTEM (in MAIN.ASM) described above. The routine GET_TOUCH_TONE detects the "1" touch tone and waits for it to terminate.

The call progress system is initialized by CALLP_INIT which initializes the analog interface circuit 40 and the input counters. The mean square outputs are inspected every 256 sample times (35.5 millisecond intervals) to simplify division of the mean square values.

CALLP_MAIN performs the DMA initialization and waits for 256 samples to be received and the filter outputs to be computed. It then tests the mean square values to determine if an answer tone has a sufficient magnitude (at least 4000H and also greater than 1/4 of the total energy on the line), and that such a tone has been present for a predetermined duration. CALLP_MAIN also calls PRINT_CALLP which displays the mean square filter output levels (useful for testing and debugging). The routines TOUCH_TONE_DETECT and PRINT_DTMF are similarly available to indicate the receive levels coming through the DTMF filters for testing purposes.

The routine GET_END_ATONE is called after a valid answer tone has been detected. It resets the call progress counters to 4.44 milliseconds in order to detect the end of an answer tone more quickly This routine also enables the transmitter DMA to start the 1200 bps transmitter as part of the training sequence leading to 2400 baud transmission. The routine then waits for the remote location to terminate the answer tone, which triggers the beginning of the 1200 bps receiver function. As soon as the end of the answer tone is detected, the AIC is set to receive at 9600 samples per second.

RECEIVER FILTERING, AGC AND INTERPOLATION

The digitally expressed incoming analog sample amplitudes are processed by the microprocessor 22 in the host computer system 20 to filter the desired received signals from other signals outside its passband, to split the incoming signal int its two phase-shifted quadrature components, to r gulate the signal level of the incoming signal by m ans f automatic gain contr l

processing, and to compensate for variations in the baud rate of the incoming data by an interpolation procedure. All of these steps, which occur prior to demodulation, are handled by the module listed in RECVFIL.ASM.

Filtering consists of running the samples through either a high or low bandpass filter to reject the modem's local transmitter. Phase splitting reduces the samples to two sets of complex numbers (real and imaginary) for each baud time of samples (the baud rate being 600 per second), resulting in 1200 complex numbers per second.

The phase splitting occurs at FILTER_PQ in RECVFIL.ASM. FILTER_PQ is a two stage filter specifically designed to reduce the number of multiplication's and thus reduce execution time. Because of the computational burden placed on the host computer's processor when filtering and demodulating the incoming analog samples, it is essential that efficient algorithms be employed if processors which are in widespread use are to be capable of handling the high baud rates employed by conventional modems now in use. Th efficiency of the FILTER_PQ routine, when combined with the efficient demodulation scheme to be described, has been shown to be capable of receiving and demodulating a conventional V.22bis, 2400 baud modem transmissions when executed by a conventional IBM-AT class Personal Computer employing an Intel 80286 microprocessor operating at 12 Mhz.

As can be seen at the label FILTER_LOOP, the Cosine and Sine variables are either zero or plus or minus 1/4. These values reduce the number of multiplication's and improve operation speed. LOW_STAGE1 and HI_STAGE1 do the pass-band to base-band conversion (4800 and 9600 sample rate conversion down to 2400 samples per second). LOW_STAGE1 performs the front end filtering of the receive low band samples. 4800 samples per second are reduced to 2400 by reading in a single sample and skipping the second because the second Cosine is zero for a total of two samples per loop. HI_STAGE1 reads in the 9600 samples a total of two times, skipping every other one (4 samples per loop) thus reducing the number f samples to 2400. Next the utput of the first stage is sent through STAGE2 t be filtered.

At REAL_DONE, the output value of this routine is divided by 128 or 16 depending on the AGC reaction speed (AGC computed over 16 or 128 samples) and then the absolute value is added to the AGC sum. Each output is then AGCed to bring it up to the correct level.

The same samples are then processed in the same way by the imaginary filter, DO IMAGINARY. At IMAG_DONE, the imaginary number is added to the AGC sum variable and the multiplication is performed to yield the automatic gain controlled output value. At this point, one quarter baud times worth of samples (one 2400th of a second) have been computed, and the process proceeds by reducing the sample rate to 1200 through the interpolator. Because two or four samples per loop are being handled, the routine is optimized to reduce the number of delay line shifts needed.

The INTERPOLATOR_ROUTINES perform the baud loop timing for the modem by computing one set of real and imaginary numbers for each two sets of input samples. The routine also looks for differences in timing between the input sample rate and the remote transmitter's sample rate. If the remote transmitter's crystal frequency is a littler faster than the sampling rate established by the analog interface circuit 40 so that, for example, the remote transmitter is sending 1201 real and imaginary pairs per second instead of the standard 1200, the INTERPOLATOR_ROUTINES will generate an additional pair of samples every second. Conversely, one fewer pair will be generated if the remote end is operating at a slower rate than expected. This allows the disclosed arrangement to lock onto the remote end's transmitted baud rate without having to adjust the rate at which samples are delivered via the fixed-rate DMA transfers required by the host computer system.

INTERPOLATOR_ROUTINES is called by a pointer named BAUDLP_VECTOR immediately after the label ADD_IMAGINARY in RECVFIL.ASM. This routine alternates between buffering the first set of samples and secondly, computing the 1200 rate real and imaginary inputs required by the receiver. Inside SAVE_S1 there is a c unter called QUAD_COUNT which, when decremented to zero, indicates that it is time to c mpute new interp lator coefficients by a jump

to NEW_COEFF. This routine looks at the BAUD_X variable in DEMOD.ASM for an underflow or an overflow. These conditions indicate it may be time to compute and extra set of real and imaginary numbers or to skip the next pair. The final sets of real and imaginary numbers (Ps and Qs) are stored in buffers called REAL_BUFFER and IMAG_BUFFER. Because the FILTER_PQ routine can return back with anywhere from 1 to 3 sets of Ps and Qs, those sets are buffered so that DEMOD can handle the under flow/overflow.

When INTERPOLATOR_ROUTINES is finished, control is returned to FILTER_PQ which then loops three more times, followed by a check to determine if the end of the receive sample buffer has been reached, and if the filter delay lines are full. If so, the delay line variables are copied from the end of the buffer to the beginning, the pointers are reset, and the routine is exited. By using long buffers for the delay lines, it is unnecessary to constantly shift these numbers within the delay lines, thus saving execution time.

DEMODULATION

When filtering and interpolation are completed, control is returned to label EQUALIZER_BUF_CHECK in DEMOD (listed in DEMOD.ASM). A check is performed to determine if there are two sets of Ps and Qs in the buffers. If present, they are copied to equalizer input buffers named EQR_DELAY and EQI_DELAY. At this time, the BAUD_SUM variable is set for use by the baud loop routine used for interpolation. BAUD_SUM is set by adding the absolute values of the first set of Ps and Qs and subtracting the second set.

The next routine provides automatic gained controlled amplification (AGC). The first thing done is a check of the baud counter to see if four r thirty-two baud times have passed (corresponding to the 16 or 128 divisor used to calculate the AGC average in FILTER_PQ as discussed above). If appropriate, a check is then to determine if the flag that indicates a valid energy level on the phone line has been set. If not, at ENERGY_CHECK, the current energy lev 1 (AGC_AVERAGE) is inspected to se if it is above the minimum level (-43 dBm) indicated by ENERGY_THRESHOLD. If there is still no

energy, jump (via NO_ENERGY) to EQUALIZER_FULL_CHECK at the end of DEMOD which insures that the equalizer delay lines do not overflow.

If there is energy for the first time, calculate a new AGC multiplier (at NEW_LEVEL) and start up the receiver. This routine is needed when the user has entered F1 from the initial command buffer (direct to data mode) in order not to run the adaptive equalizer with no input signal. If energy has already been detected and the correct number of baud times has been reached, control is passed to AGC_TESTS.

Before the AGC tests are performed, a routine labeled CHECK_ALPHA slows down the equalizer gain term after 256 baud times. The variable ALPHA is high during training so as to bring the receiver up more quickly. After 256 baud times, ALPHA is reduced to increase performance and reduce variability.

If the AGC is in wide band mode (fast reacting), control then passes to WIDEBAND_AGC; otherwise, a check is made to see if the new AGC_AVERAGE is either one-half the level or greater than 1.5 times the last AGC_AVERAGE. If it is, control is passed to NEW_LEVEL to compute an AGC multiplier just on that new value. This lets the receiver act quickly to gain hits on the phone line. If neither of these tests pass, the routine adds 1/8th of the new to 7/8ths of the old level, and computes a new multiplier from the sum. In this way the AGC reacts smoothly and does not vary quickly, which improves performance on a line with little signal level variations.

COMPUTE_AGC takes the new AGC_AVERAGE and computes AGC_XSUBE and AGC_MANT, two variables which are used to adjust any receive signal level the optimal level needed by the receiver. Also, the AGC is changed from wide-band to narrow mode after the first 32 baud times (as seen immediately before the label DISPLAY_BOX in the AGC routine).

DISPLAY BOX checks the RECV_FLAGS register to see if the user is in the display box view mode. If so, the current display box variable is gathered by calling the routine pointed to by DBOX ROUTINE and then the appropriate point is plotted on the scilloscope screen as noted earlier.

The next routine updates the baud loop variables used by the interpolator routine in FILTER_PQ. The baud loop is controlled by two different loops. A first order baud loop does fine tuning and a second order loop makes coarse adjustments to get the baud loop close to the optimal timing. Every eight baud times the sign of BAUD_SUM is checked. Depending on the sign, a decimal 160 is added or subtracted from BAUD_X. Also, BAUD_SUM is divided by 128 and added to LOOP_INT2, the second order baud loop integrator. LOOP_INT2 is then checked to make sure it stays within the bounds of F200 to 0EFF, hexadecimal. This puts a maximum limit on how much the baud loop can correct for timing differences between itself and the remote modem.

At BAUD_LOOP2, a counter called LOOP2_CNT is decremented. When it reaches zero, the sign of LOOP_INT2 is checked and 160 is added or subtracted from BAUD_X. At label GET_NEW-COUNT, LOOP2_CNT is reloaded from the table BAUD_LOOP2_TABLE (defined at the beginning of the DEMOD.ASM listing immediately before the code). The value loaded from BAUD_LOOP2_TABLE is determined by an offset into the table which comes from the high order eight bits of LOOP2_INT. As LOOP2_INT grows to bigger levels, LOOP2_CNT is reloaded with a smaller and smaller count, causing the second order baud loop to make more frequent adjustments to BAUD_X. BAUD_X is then used by the interpolator to know when to skip or add an extra set of Ps and Qs to the equalizer delay line.

The routine EQUALIZER_OUTPUT generates the actual receive data point from the incoming Ps and Qs. The algorithm performs a complex number multiplication between the complex numbers in the equalizer delay line and the complex taps. Each of the last 7 baud times (14 taps) of Ps and Qs are multiplied with their respective taps and the results are summed. What results is the complex number RZN + j IZN, which is the data point.

In the following routine, PHASE_ROTATION, the equalizer output is rotated into the correct quadrant by the Cosine and Sine of the phase angle PHI. This is done through the multiplicati n of RZN + j IZN by negative COSINE + j SINE. The resulting point is RYM + j IYM.

The next routine performs the calculations to determine which point in the signal constellation RYM + j IYM is closest to. Once this is determined, the data pattern associated with this point is known and the demodulation of the analog signal is complete. Also, the nearest perfect point is saved into DEC_R + j DEC_I and an error vector from this point to the point we demodulated is generated and stored into R_ERROR + j I_ERROR. There are separate routines 1200 and 2400 baud because the signal constellations are different.

For 1200 baud, because there is only four possible points, the process is as simple as comparing the signs of both RYM and IYM to determine which of the quadrants the point resides in. At label DECISION_1200, the sign of RYM is tested. If it is positive, the absolute decision point, 49 * 256, is placed in DEC_R, and this value is subtracted from RYM to get the error vector, R_ERROR. Also, the offset into DECISION_TABLE, where the actual data sent from the other end is decoded, is placed into the BL register. This process is repeated for IYM to yield DEC_I and I_ERROR. At the label READ_DECISION, the receive data is read out of DECISION_TABLE and placed into RECV_DATA.

The process for decoding data at 2400 bits per second is a little different in that there are sixteen possible decision points. Consequently, the routine inspects the sign of RYM and j IYM, as well as their magnitudes. Once the error vectors and decision points are determined, the code branches to READ_DECISION and the receive data is read out of DECISION_TABLE as in the 1200 case above.

The next step is to update the taps with the counter-rotated error vector. By doing this, the taps learn what types of errors are being generated by the phone line and they move in a direction that can correct for these errors. The counter-rotated error vector is scaled down by ALPHA so that the taps cannot be significantly changed by any one baud time error. The counter rotation is done my multiplying R_ERROR + J I_ERROR by COSINE - j SINE, and then again multiplied by ALPHA. The results are placed in AREN + j AIEN.

The routine DO_TAP_UPDATE multiplies all fourteen of the taps (RW + j IW) by (AREN + J AIEN). Before this, however, the taps are all "bled" a little to keep them from becoming too big. This is done by repeating the macro BLEED_TAP (defined at the beginning of the DEMOD.ASM listing) 28 times, each time adding four to a negative tap or subtracting four from a positive tap, thus pulling all taps toward zero. BLEED_TAP is performed for both the real and imaginary parts of all taps.

Next, the phase loop is updated so that it can recalculate COSINE and SINE for the next baud time. To do this, the output of the equalizer RYM + j IYM must be multiplied by the negative of the decision point DEC R - j DEC I. Only the imaginary vector is needed so RERR need not be recalculated. Thus, IERR = (IYM * DEC R) - (RYM * DEC I). Also, the routine multiplies IERR by two to meet the needed gain for PHASE_UPDATE.

PHASE_UPDATE employs a first and second order phase loop which locks onto the phase roll of the remote transmitter. PHI is the new phase angle determined by the code. The upper eight bits of PHI are then used to access a pre-computed COSINE and SINE from the tables listed in TONES.ASM. This algorithm use of tables indexed by the phase angle PHI substantially improves execution speed by eliminating multiplications.

The S1_DETECT routine functions is a matched filter which detects the presence of the S1 digit sequence defined in the V.22bis CCITT specification. The S1 transmit sequence is used to signal the remote receiver that the other end is a 2400 baud modem, or that the other end wants to initiate a 2400 baud retrain. The S1 sequence is composed of unscrambled 11's then 00's at 1200 baud that create a specific tone on the line. S1_DETECT determines the presence of the tone by looking at the numbers in the real equalizer delay two baud times apart. If the difference in these numbers is above a certain threshold a counter, S1_COUNTER, is incremented. If the difference is below the threshold, the counter is decremented by four. If the counter ever reaches 20, S1 has been detected.

The routines starting at DATA_DECODE perform the necessary computations to parse the incoming data stream into ASCII characters.

At 1200 baud, the two received data bits are stored in bits 2 and 3 of RECV_DATA.

At 2400 baud, the incoming data is decoded in accordance with the V.22 and V.22bis specification. bits 0 through 3 are valid data. First, differential decoding is performed by subtracting the previous baud times' bits 2 and 3 from the baud time's data. Next, the Gray decoding process checks bit 3 and, if it is zero, bit 2 is inverted. Descrambling parses four bits at a time so that, at 1200 baud, the first baud times data bits are placed into DATA_1200, the routine waits for the second baud times data, and then combines the two at COMBINE_1200_DATA before descrambling. DESCRAMBLE_4 performs the descrambling routine specified in V.22 and V.22bis.

After the descrambler, the data is now in the same format as sent to the modem by the remote data terminal equipment: asynchronous ASCII data. The routine then searches the incoming data for a start bit, parse the next eight data bits into an ASCII character, and then puts the result into the receive character buffer for the terminal loop to display on the screen.

At RECEIVE_PARSER, a state variable R_PARSE_JMP is tested to see if it's zero and, if it is, the routine jumps to CHECK_FOR_START to look at the four bits out of the descrambler to see if there are any zeros present. If there are, the data is moved into R_PARSE_DATA, and R_PARSE_JMP is set to PARSE_8. The next time into the loop, RECEIVE_PARSER jumps to PARSE_8 where the next four receive bits are combined into R_PARSE_DATA. Four data bits are still needed to complete the ASCII data, so R_PARSE_JMP is set to PARSE_12.

At PARSE_12, enough data has been collected to form the character, so it is now necessary to determine where the character is in the received 12 bits of data. This depends on where the start bit is located. PARSE_12 begins by shifting the received 12 bits right until a zero enters the carry flag. Once a zero is d tected, the ight data bits of the receive character are in the AL register, fr m which they can be stored int RX_CHAR_BUF, and the pointers

into R_CHAR_BUF are updated. The bit counters are then checked to see how many of the received 12 bits are left. Depending on where the start bit was located there can be up t three data bits left over. These bits are checked to see if there is another start bit. If there is, the routine recreates R_PARSE_DATA so that it has four valid bits in the low order and resets R_PARSE_JMP to PARSE_8. Code outside the interrupt handling routines checks to see if any characters have been placed in RX_CHAR_BUF and displays them in terminal mode.

The last thing done by the receiver, at EQUALIZER_FULL_CHECK, is to make sure that the equalizer delay line buffers are not full. The previous 6 baud times worth of Ps and Qs must always be available; consequently, when the equalizer is full, the last 12 Ps and Qs are copied to the beginning of the EQR_DELAY and EQI_DELAY. Also, the EQUALIZER_IN pointer is reset to point into location 13.

MODULATION

The transmitter routines listed in TX.ASM are substantially less complex than the demodulation routines because modulation is a determinate process.

The first two routines in TX.ASM, INIT_TX and SETUP_SAMPLE_COUNT, initialize the transmitter variables. INIT_TX resets the pointers into the transmitter sample buffers and calls SETUP_SAMPLE_CNT which tests to see if transmission is to be performed in the low band (8 samples per baud time) r high band (16 samples per). SETUP_SAMPLE_COUNT also sets up the transmit buffer threshold, SAMPLE_COUNT, to either 100 samples for low band or 200 for high band. SAMPLE_COUNT insures that there are always enough samples in the buffer to handle the case where the transmitter routine will not receive control for a prolonged period (which occurs, for example, when interrupts are turned off while the PC is changing video modes). This safeguard adds a 20 ms delay into the transmit path.

TX1224, the code which performs the actual transmission, is reached through the transmit vector, TX_VECTOR, in the interrupt handling routine

SOFTMODEM in INTS.ASM which, as described above, receives control each time the interface card 15 generates an interrupt at every 16th receive sample.

The first thing TX1224 does is check the number of samples in the transmit buffer. If the count is less than SAMPLE_COUNT, another baud times worth of samples is processed. DO_TX is the actual start of the transmitter process. Flags are first checked to see if the system is operating in a forced data mode in which all marks (ones) or the dibit pattern S1 is to be sent. If either of these flags is set, control is passed to SEND_MARKS.

At CHECK_TX_DATA, the routine first checks to see data is being parsed. If so, control is passed to the routine pointed to by T_PARSE_JMP. If not, control is passed to CHECK_TX_CHAR where a test is performed to determine if any ASCII characters to be sent are present in TX_CHAR_BUF. If there are none, control is passed to SEND_MARKS. If characters are ready to be sent, they are read from TX_CHAR_BUF, the pointers to that buffer are updated, and a start bit is inserted into the data before it is stored in SEND_DATA. The parser vector, T_PARSE_JMP, is set to PARSE_4_2_DATA.

The PARSE_DATA routines are listed at the end of TX.ASM. PARSE_4_2_DATA sets the parser vector to PARSE_2_DATA, obtains the next four data bits of the ASCII character and returns. PARSE_2_DATA then takes the last data bit of the character, appends on three stop bits, and checks for another character to be sent. If there are no more characters to be sent, the routine resets T_PARSE_JMP to zero and returns. If there is a character to be sent, the routine gets the character and updates the buffer pointers, and then shifts the character left three bit positions such that this new character is given a start bit. The routine then inserts the two remaining bits of the last character and saves it off. Next, the new character is shifted right by four, a stop bit is inserted, and T_PARSE_JMP to set to PARSE 4_4_DATA. PARSE_4_4_DATA parses the next four bits of the TX char and sets T_PARSE_JMP to PARSE_4_0 DATA. PARSE 4_0_DATA parses the last three bits of the second data byte plus the st p bit and resets T_PARSE_JMP t zer s that th pr cess is returned t state 0.

As seen in TX.ASM at SCRAMBLER, the data is scrambled using the algorithm specified by the V.22 and V.22bis specification. At CHECK_1200, the low order two bits of the scrambler output are saved for the next baud time. The next two processes, GRAY_ENCODE and DIFF_ENCODE perform the appropriate Gray and differential coding defined in the V.22 and V.22bis specification.

The next routines process the transmit data into sample amplitude values which are delivered to the interface card 15 for digital-to-analog translation by the AIC 40. For each possible data value there are six sets of samples, and the pointers to these samples are called AN0_PTR, AN1_PTR, AN2_PTR, BN0_PTR, BN1_PTR, and BN2_PTR. AN0_PTR and BN0_PTR are read from a table at an offset location equal to the current transmit data value. The other four pointers are the AN0 and BN0 pointers saved from the last two baud times. Next, the transmit sample is created by adding the three values pointed to by the AN pointers, multiplying them by 1 or -1 depending on which sample is being formed, and putting the result into TEMP_TX_BUF. Next, the three values pointed to by the BN pointers are added together and the sum is either added or subtracted from the corresponding TEMP_TX_BUF value depending on the 1 or -1 multiplier. This process is done for either 8 or 16 samples, depending on whether transmission is to be made in the low or high band respectively. Once the samples are completely formed in TEMP_TX_BUF, they are copied into the transmit sample buffer making sure to take into account the position of the end of the buffer.

When transmitting low band samples during the training sequence, it is necessary to change the receive sample rate from 7200 samples per second (needed for call progress functions) to 9600 samples per second needed by the receiver code. To change the sampling rate, AIC commands are imbedded into the data stream in the routine SEND_AIC_CMDS. This routines takes a transmit sample, ORs it with binary 3 which tells the AIC there is a command following this data sample, and the puts the command into the next location. To change the sample rate, two consecutive commands are sent.

The process differs during high band transmission. Alternating samples are filled with the sum of the AN's and then the sum of the BN's, and the need to send AIC commands does not arise; consequently, there is always room in the sample buffer for a full baud times worth of samples. Once the TX samples have been moved into the TX sample buffer, the HIGH_BAND_FILTER routine shifts the AN and BN delay lines and returns.

The functions provided to the user by the program described are, of course, merely illustrative of the communications functions which can be implemented by suitably programming the host processor to exchange information with the interface card. In addition to the 1200 baud, originate mode modem communications capability implemented as operational code in the program listing which follows, much of the code necessary to implement 2400 baud V.22bis modem communication is also included in the following listing, although a fully operative 2400 baud system has not been completed and henc the 2400 baud routines that are included have not been fully tested. It should also be noted that the disclosed hardware, suitably programmed, can provide a variety of additional functions, such as facsimile and synchronous data transmission, as well as other modem modulation schemes such as the Bell 208 or U.S. Robotics HST asymmetrical transmission modes. Additional routines for performing more elaborate line equalization, echo suppression, adaptive transmission rate adjustment ("fall forward" and "fall back" to adjust to transmission noise conditions), error correction and data compression algorithms can be readily implemented by programming the host processor to manipulate transmitted and received data, either on either a concurrent, real-time basis, or by processing the data before transmission begins or after it concludes. It should also be noted that, because the telephone interface operates under direct control of the host processor, it is unnecessary to embed control sequences (e.g. AT command code sequences) within the data stream to provide communications control functions. It is acc rdingly possible t much more rapidly respond t events which ccur, either in the host c mputer, the teleph ne link, or at the remote data

terminal equipment, so that flow control procedures (for example) can be more rapidly, m re transparently, and m re effectively handled than is currently possible with separate m dems which must be controlled by escape signals imbedded in the data stream, typically with mandatory guard times which accompany the unique pattern of characters forming the escape signal.

Most importantly, however, the present invention is implementing virtually any voice or digital communications function which can be accomplished over voice-grade lines without needing different hardware. This versatility is achieved by transferring substantially all of the functionality from the conventional separate communications processor (which is typically programmed with resident firmware and/or employs special purpose analog or digital circuitry for signal processing functions) to the available processor in the host computer, which can be programmed to perform a suite of functions whether presently available or yet to be developed.

It is to be understood that the arrangement which has been described, and which is implemented by the programs listed below, is merely illustrative of one application of the principles of the invention. Numerous modifications may be made by those skilled in the art without departing from the true spirit and scope of the invention.

PROGRAM LISTING

The assembly language listing for the modules discussed above appears below:

```
;%%%%%%%%%%%%% COPYRIGHT  1993 U.S.ROBOTICS, INC. %%%%%%%%%%%%%%%
.model small
.286
.stack      200h
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
;     MAIN (the user interface into the modem)
;
;     Main sets up the DMA channels and initializes the modem
;     interrupts.
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

      include      equates

      public       vid_mode,rx_sample_segment,tx_sample_segment
      public       ds_segment,tx_dma_ala16,rx_dma_ala16
      public       set_aic_bands,init_dma,speaker_on,speaker_off
      public       on_hook,off_hook,tx_dma_off,rx_dma_off
      public       display_segment,attribute,init_aic
      public       init_aic_tx48_rx72,sreg
      public       init_tx_dma,tx_dma_on
      public       rx_dma_on,main_flags

      extrn init_dbox:near,init_tx:near,init_recv:near
      extrn demod:near,tx1224:near,softmodem:near
      extrn dbox_address:near,init_timer:near
      extrn disable_int:near,wedge_int:near
      extrn nul_routine:near,send_tones:near
      extrn dial:near,init_screen:near,window_flip:near
      extrn ring_detect:near,no_ring_state:near
      extrn save_screen:near,restore_screen:near
      extrn init_comm_screen:near,screen_out:near
      extrn callp_main:near,print_parity:near
      extrn touch_tone_detect:near,dtmf:near,init_callp:near
      extrn get_callp:near,get_touch_tone:near

      extrn rx_char_in:word,rx_char_out:word
      extrn tx_char_in:word,tx_char_out:word
      extrn rx_char_buf_start:word,rx_char_buf_end:word
      extrn tx_char_buf_start:word,tx_char_buf_end:word
      extrn recv_flags:word,rx_out:word,baud_count:word
      extrn tx_in_ptr:word,tx_flags:word
      extrn recv_vector:word,tx_vector:word
      extrn freq:word,ring_state:word

      extrn main_menu:byte,start_message:byte,end_message:byte
      extrn int_flags:byte,outgoing_msg:byte,rec rding_msg:byte

      buffer_word_size  equ   8192-1
```

```
        stack_length            equ   200h/16
        rx_buf_len        equ   8192 * 2
        tx_buf_len        equ   8192 * 2

.data
        main_flags  dw    ?
;       main_flags.0      - 1  No recv data
;       main_flags.1      - 1  Auto-answer in data mode versus voice mode
;       main_flags.2      - 1  TX DMA on
;       main_flags.3      - 1  Ignore Loop Loss
;       main_flags.4      - 1  Loop loss status
;       main_flags.5      - 1  Annouce rings

;       main_flags.8      - 1  Odd/Mark  - 0  Even/Space
;       main_flags.9      - 1  Force parity
;       main_flags.10     - 1  Parity ON

        dbox_ok           db    ?     ; <>0 - graphics adaptor present
        vid_mode    db    ?     ; save the old video state
        out_latch   db    ?     ; image of output latch
        temp_address_low dw     ?
        temp_address_high dw    ?
        init_AIC_tx96_rx96      dw    9,9,3,0ff47h,03h,1e3ch,03h,0dh
                          dw    03h,3872h,0,0,0,0,0,0
        init_AIC_voice          dw    9,9,3,0ff47h,03h,1c38h,03h,0dh
                          dw    03h,50a2h,0,0,0,0,0,0    ; RX 7200
        init_AIC_tx48_rx96      dw    9,9,3,0ff47h,03h,383ch,03h,0dh
                          dw    03h,3c72h,0,0,0,0,0,0
        init_AIC_tx48_rx72      dw    9,9,3,0ff47h,03h,3838h,03h,0dh
                          dw    03h,3ca2h,0,0,0,0,0,0

        init_AIC_tx96_rx48      dw    9,9,3,0ff47h,03h,1e70h,03h,0dh
                          dw    03h,387ah,0,0,0,0,0,0
        init_AIC_tx48_rx48      dw    9,9,3,0ff47h,03h,3870h,03h,0dh
                          dw    03h,3c7ah,0,0,0,0,0,0

        ds_segment        dw    ?
        psp_segment       dw    ?     ; program segment prefix
; Dynamically allocated sample buffers
        tx_sample_segment dw    ?
        tx_dma_ala16            dw    ?
        tx_dma_page       dw    ?

        rx_sample_segment dw    ?
        rx_dma_ala16            dw    ?
        rx_dma_page       dw    ?

        ram_error_msg           db    cr,lf,'Insufficient RAM',cr,lf,'$'
        shrink_err r_msg  db    cr,lf,'Error during RAM shrink',cr,lf,'$'
        display_segment         dw    ?
```

```
        attribute           db      ?
    EVEN
        playback_file               db      'msgl.dat',0,0,0,0,0,0,0

; MODEM SPECIFIC REGISTERS
        sreg    dw      1,0,43,13,10,8,2,30,2,17,7,70
.code
SOFT_MODEM  PROC  NEAR

        mov     dx,@data
        mov     ds,dx
        cld
        mov     psp_segment,es
        mov     ds_segment,ds               ; save for further reference

; shrink RAM to the size of the program
        mov     bx,ss                   ; find the end of the program
        add     bx,stack_length             ; add length of the stack in paragraphs
        mov     ax,es
        sub     bx,ax                   ; subtract start of the program
        inc     bx                      ; add one for good measure
        mov     ah,4ah                      ; shrink ram
        int     21h                     ; ES points to PSP
        mov     dx,offset shrink_error_msg
        jc      alloc_error

        mov     es,ds_segment
        call    allocate_buffers ; get the two 8K word sample buffers
        jnc     alloc_ok

        mov     dx,offset ram_error_msg
alloc_error:
        mov     ah,09h
        int     21h
exit_jmp:
        jmp     main_exit

alloc_ok:
        mov     out_latch,0ffh

        mov     ah,0fh                  ; get the current video mode and save
        int     10h
        mov     vid_mode,al

; presence test for EGA/VGA
        mov     dbox_ok,0
        xor     bx,bx
        mov     ax,la00h        ; VGA display info
        int     10h
        cmp     al,lah                  ; AL returned as lah if supp rt d
```

```
        jne     no_vga
        mov     db x_ok,0ffh
        jmp     short presence_done
n _vga:
        mov     ah,12h              ; EGA display info
        mov     bl,10h
        int     10h
        cmp     bl,10h              ; if bl remains the same the no EGA
        je      presence_done
        mov     dbox_ok,0ffh
presence_done:
; get the display segment
        int     11h                       ; color or monochrome monitor ?
        and     ax,30h
        cmp     ax,30h
        mov     display_segment,mono
        mov     attribute,07h
        je      mono_disp
        mov     attribute,01bh
        mov     display_segment,color_seg
mono_disp:

        mov     main_flags,0              ;
    IF board
        lea     si,init_aic_tx96_rx96     ; tx 9600 rx 9600
        call    init_aic
        call    init_dma

        mov     ring_state,offset no_ring_state
        mov     recv_vector,offset ring_detect
        mov     tx_vector,offset nul_routine
        call    wedge_int

; check for any command line options
        mov     es,psp_segment
        mov     bx,80h
        mov     cl,[es:bx]          ; get the command line option count
        xor     ch,ch
        inc     bx
        cmp     cx,0
        je      init_ring
space_loop:
        mov     al,[es:bx]
        inc     bx
        cmp     al,' '
        jne     got_char
        loop    space_loop
got_char:
        dec     bx
        lea     si,playback_file
```

```
        cmp     cx,12
        jle     get_name
        mov     cx,12
get_name:
        mov     al,[es:bx]
        inc     bx
        mov     [ds:si],al
        inc     si
space_off:
        loop    get_name

        xor     al,al               ; terminate
        mov     [ds:si],al
        call    speaker_on
        lea     dx,playback_file
        call    playback_msg
        call    speaker_off
        jmp     main_exit


init_ring:
        push    ds
        pop     es
; re-init all the vectors
        mov     ring_state,offset no_ring_state
        mov     recv_vector,offset ring_detect
        mov     tx_vector,offset nul_routine

        call    on_hook
        call    speaker_off
    ENDIF

main_screen:
; hide the cursor
        mov     ah,02h
        xor     bh,bh
        mov     dh,25
        mov     dl,0
        int     10h

        and     main_flags,0700h  ; every thing but parity
        call    init_screen
        call    print_parity

main_loop:
    IF board
        call    on_hook
    ENDIF
no_hangup:
        lea     si,main_menu
```

```
        call  wind w_flip

g t_key:
        mov   ah,1
        int   16h
        jnz   menu_command

        test  int_flags,b0
        jz    get_key               ; check for ring

        and   int_flags,0feh

        test  main_flags,b0
        jnz   aa_data

        lea   si,main_menu
        call  window_flip

        call  answering_machine
        jmp   short main_loop

aa_data:
;       call  aa_comm_mode
        jmp   short main_loop

menu_command:
        mov   ah,0
        int   16h

        cmp   ax,F1
        jne   chk_record

        lea   si,main_menu
        call  window_flip

        call  originate_mode_init
        call  comm_mode
   IF board
        jmp   short init_ring
   ELSE
        jmp   short main_screen
   ENDIF

chk_record:
        cmp   ax,F2
        jne   chk_playback

        lea   si,main_menu
        call  window_flip
```

```
        call  off_hook
        call  speaker_off
        or    main_flags,b3          ; ignore loop loss

        lea   si,start_message
        call  window_flip

        mov   ah,0                 ; get a key
        int   16h

        lea   si,start_message
        call  window_flip

        lea   si,end_message
        call  window_flip

     IF board
        lea   dx,out_msg
        call  record_msg
     ELSE
        mov   ah,0
        int   16h
     ENDIF

        lea   si,end_message
        call  window_flip

        jmp   main_loop

chk_playback:
     IF board
        cmp   ax,F3
        jne   chk_tone

        lea   si,main_menu
        call  window_flip

        call  on_hook
        call  speaker_on

try_again:
        lea   dx,playback_file
        call  playback_msg
        jc    bad_play

        mov   bx,offset playback_file
        inc   byte ptr [bx+3]

n _files:
        call  speaker_off
```

```
        jmp   main_loop

bad_play:
        m v   bx,offset playback_file
        cmp   byte ptr [bx+3],'1'
        je    no_files
        mov   byte ptr [bx+3],'1'
        jmp   short try_again

    ENDIF
chk_tone:
        cmp   ax,F4
        jne   chk_dial

        lea   si,main_menu
        call  window_flip

    IF board
        call  speaker_on
    ENDIF

        mov   freq,tone_2225
        mov   ax,1000                    ; ten seconds
        call  send_tones

    IF board
        call  speaker_off
    ENDIF

        jmp   main_loop

chk_dial:
        cmp   ax,F5
        je    originate_mode
        jmp   chk_F6

originate_mode:
        lea   si,main_menu
        call  window_flip

        call  dial
    IFE board
        jmp   no_hangup
    ELSE
        mov   sreg+9,17           ; 600 ms of answer tone
        mov   sreg+7,30           ; 30 second time out
        call  callp_main
        jnc   got_atone
        jmp   main_loop
g t_atone:
```

```
	call	setup_lo p_current

	or	recv_flags,1h		; recv_high
	call	init_c mm_screen

	and	main_flags,NOT b0
	call	init_recv

	or	recv_flags,08h		; data mode
;	cmp	dbox_ok,0
;	je	no_dbox1
;	and	recv_flags,0fff7h
;	call	init_dbox
;no_dbox1:
	call	init_rx_dma

	cli
	mov	ax,150
	call	init_timer
	mov	recv_vector,offset demod

; enable DMA channel 2  RECV DMA
	call	rx_dma_on
	sti

wait_connect:
	test	recv_flags,b5
	jz	wait_connect
	call	speaker_off
	mov	rx_char_in,offset rx_char_buf_start
	mov	rx_char_out,offset rx_char_buf_start

	call	comm_mode
	jmp	init_ring
    ENDIF

chk_f6:
	cmp	ax,F6
	jne	chk_ttone_detect

	lea	si,main_menu
	call	window_flip

	call	callp_main
	jmp	no_hangup


chk_tt ne_detect:
	cmp	ax,F7
	jne	chk_message_system
```

```
        lea     si,main_menu
        call    wind w_flip

        call    off_ho k
        call    speaker_on

        call    touch_tone_detect

        call    on_hook
        call    speaker_off
        jmp     no_hangup

chk_message_system:
        cmp     ax,f8
        jne     chk_on_off_hook

        lea     si,main_menu
        call    window_flip

        call    messaging_system

        jmp     no_hangup


chk_on_off_hook:
    IF board
        cmp     ax,ALT_H
        jne     chk_spkr

        mov     dx,modem_board
        xor     out_latch,1
        mov     al,out_latch
        out     dx,al
        jmp     get_key

chk_spkr:
        cmp     ax,ALT_S
        jne     chk_parity

        mov     dx,modem_board
        xor     out_latch,8
        mov     al,out_latch
        out     dx,al
        jmp     get_key
    ENDIF

chk_parity:
        cmp     ax,ALT_P
        jne     chk_answer_mode
```

```
        call  new_parity
        jmp   get_key

chk_answer_mode:
        cmp   ax,ALT_A
        jne   chk_exit

        xor   main_flags,b5           ; change answering machine answer mode
        jmp   get_key

chk_exit:
        cmp   ax,F10
        je    main_exit
        jmp   get_key

main_exit:
        call  disable_int

        mov   ah,15         ; CLS
        int   10h
        mov   ah,0
        int   10h

        mov   ah,4ch              ; exit
        xor   al,al
        int   21h

SOFT_MODEM  ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
INIT_DMA    PROC  NEAR

        call  tx_dma_off
        call  rx_dma_off

        mov   dx,wr_cmd           ; command register
        mov   al,00000000b
        out   dx,al
        jmp   $+2

        mov   dx,wr_mode
        mov   al,01011001b              ; channel 1
        out   dx,al
        jmp   $+2

        mov   al,01010110b              ; channel 2
         ut   dx,al
        jmp   $+2
```

```
      call  init_tx_dma
      call  init_rx_dma

      ret

INIT_DMA    ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
INIT_TX_DMA PROC  NEAR

      mov   dx,wr_clr_byte_ptr      ; init flag to low byte
      out   dx,al
      jmp   $+2

      mov   ax,tx_dma_a1a16
; AX contains A1 - A16 of the tx buffer
      mov   dx,dma_5_address
      out   dx,al
      jmp   $+2
      mov   al,ah
      out   dx,al
      jmp   $+2

      mov   ax,tx_dma_page
      mov   dx,dma_5_page
      out   dx,al
      jmp   $+2

      mov   dx,wr_clr_byte_ptr      ; init flag to low byte
      out   dx,al
      jmp   $+2

; Write the buffer size to each channel
      mov   ax,buffer_word_size
      mov   dx,dma_5_count
      out   dx,al
      jmp   $+2
      mov   al,ah
      out   dx,al
      jmp   $+2

      ret

INIT_TX_DMA ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
INIT_RX_DMA PROC  NEAR
```

```
        mov     dx,wr_clr_byte_ptr      ; init flag to low byte
        out     dx,al
        jmp     $+2

; setup the receive buffer samples
        mov     ax,rx_dma_ala16
        mov     dx,dma_6_address
        out     dx,al
        jmp     $+2
        mov     al,ah
        out     dx,al
        jmp     $+2

        mov     ax,rx_dma_page
        mov     dx,dma_6_page
        out     dx,al
        jmp     $+2

        mov     dx,wr_clr_byte_ptr      ; init flag to low byte
        out     dx,al
        jmp     $+2

        mov     dx,dma_6_count
        mov     ax,buffer_word_size
        out     dx,al
        jmp     $+2
        mov     al,ah
        out     dx,al
        jmp     $+2

        ret

INIT_RX_DMA ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
INIT_AIC    PROC   NEAR

; disable DMA channels
        call    rx_dma_off
        call    tx_dma_off

        mov     dx,wr_cmd           ; command register
        mov     al,00000000b
        out     dx,al
        jmp     $+2

        mov     dx,wr_mode
        mov     al,01011001b            ; channel 1
        out     dx,al
```

```
        jmp     $+2

        mov     dx,wr_clr_byte_ptr        ; init flag to 1 w byte
        out     dx,al
        jmp     $+2

        mov     ax,tx_dma_a1a16
; AX contains A1 - A16 of the tx buffer
        mov     dx,dma_5_address
        out     dx,al
        jmp     $+2
        mov     al,ah
        out     dx,al
        jmp     $+2

        mov     ax,tx_dma_page
        mov     dx,dma_5_page
        out     dx,al
        jmp     $+2

        mov     dx,wr_clr_byte_ptr        ; init flag to low byte
        out     dx,al
        jmp     $+2

; Write the buffer size to each channel
        mov     ax,buffer_word_size
        mov     dx,dma_5_count
        out     dx,al
        jmp     $+2
        mov     al,ah
        out     dx,al
        jmp     $+2

end_dma:
;  reset the AIC
        mov     dx,modem_board
        and     out_latch,0fbh
        mov     al,out_latch
        out     dx,al
        mov     cx,100
here2:
        loop    here2
        or      out_latch,4h
        mov     al,out_latch
        out     dx,al

; DS:SI already setup
        xor     di,di
        mov     es,tx_sample_segment
        mov     cx,16
```

```
        rep     movsw

; enable DMA channel 1
        call    tx_dma_on

wait_aic:
        mov     dx,wr_clr_byte_ptr      ; init flag to low byte
        out     dx,al
        jmp     $+2
        mov     dx,dma_5_count
        in      al,dx
        mov     bl,al
        jmp     $+2
        in      al,dx
        mov     bh,al
        cmp     bx,buffer_word_size - 14
        jge     wait_aic

; disable DMA channel 1
        call    tx_dma_off

; clear out the AIC commands
        mov     es,tx_sample_segment
        xor     di,di
        mov     cx,11
        xor     ax,ax
        rep     stosw

; AIC has been initialized
        ret

INIT_AIC        ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
MISC_ROUTINES       PROC    NEAR

off_hook:
        mov     dx,modem_board
        and     out_latch,0feh
        mov     al,out_latch
        out     dx,al
        ret

on_hook:
        mov     dx,modem_board
        or      out_latch,1
        m v     al,out_latch
        out     dx,al
        ret
```

```
speaker_on:
      mov   dx,modem_board
      and   out_latch,0f7h
      mov   al,out_latch
      out   dx,al
      ret

speaker_off:
      mov   dx,modem_board
      or    out_latch,8
      mov   al,out_latch
      out   dx,al
      ret

MISC_ROUTINES     ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
ALLOCATE_BUFFERS  PROC  NEAR

; get TX buffer first
      mov   ah,48h              ; allocate memory
      mov   bx,400h             ; 16K bytes
      int   21h
      jc    error_exitl

; now find out if the DMA address register will overflow
; AX = segment
      mov   tx_sample_segment,ax
      mov   bx,ax
      shl   ax,4
      rol   bx,4
      and   bx,0fh
      shr   bx,1
      rcr   ax,1

      shl   bx,1                ; restore A16 - A23
      mov   tx_dma_page,bx
      mov   tx_dma_ala16,ax
      cmp   ax,0                ; if the DMA address is positive
                                ; then don't worry...be happy
      jge   no_problem
      add   ax,2000h            ; word count
      cmp   ax,0
      jl    no_problem          ; still enough words
; the last buffer won't work so get the next, it will
      mov   ah,48h              ; allocate memory
      mov   bx,400h             ; 16K bytes
      int   21h
error_exitl:
```

```
        jc      rror_exit

        mov     tx_sample_segment,ax
        mov     bx,ax
        shl     ax,4
        rol     bx,4
        and     bx,0fh
        shr     bx,1
        rcr     ax,1

        shl     bx,1                ; restore A16 - A23
        mov     tx_dma_page,bx
        mov     tx_dma_ala16,ax

no_problem:
; Now get the RX buffer
        mov     ah,48h              ; allocate memory
        mov     bx,400h             ; 16K bytes
        int     21h
        jc      error_exit

; now find out if the DMA address register will overflow
; AX - segment
        mov     rx_sample_segment,ax
        mov     bx,ax
        shl     ax,4
        rol     bx,4
        and     bx,0fh
        shr     bx,1
        rcr     ax,1

        shl     bx,1                ; restore A16 - A23
        mov     rx_dma_page,bx
        mov     rx_dma_ala16,ax
        cmp     ax,0                ; if the DMA address is positive
                                    ; then don't worry...be happy
        jge     good_exit
        add     ax,2000h            ; word count
        cmp     ax,0
        jl      good_exit           ; still enough words
; the last buffer won't work so get the next, it will
        mov     ah,48h              ; allocate memory
        mov     bx,400h             ; 16K bytes
        int     21h
        jc      error_exit

        mov     rx_sample_segment,ax
        m v     bx,ax
        shl     ax,4
        r l     bx,4
```

```
        and     bx,0fh
        shr     bx,1
        rcr     ax,1

        shl     bx,1                    ; rest re A16 - A23
        mov     rx_dma_page,bx
        mov     rx_dma_ala16,ax

good_exit:
        clc
error_exit:
        ret

ALLOCATE_BUFFERS  ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
RECORD_MSG  PROC  NEAR
.data
        in_file                 db      'msgl.dat',0
        handle                  dw      ?
        end_flag        db      ?
        start_msg       db      cr,lf,'Hit a key to begin recording',cr,lf,'$'
        end_msg                 db      cr,lf,'Hit a key to stop recording',cr,lf,'$'
        bad_create      db      cr,lf,'Bad file create',cr,lf,'$'
.code
        mov     ah,03ch                 ; create file
        xor     cx,cx                   ; normal access
        int     21h
        jnc     file_ok
        lea     dx,bad_create
        jmp     error_exit
file_ok:
        mov     handle,ax

        lea     si,init_aic_voice ; tx 9600 rx 9600
        call    init_aic
        call    init_dma

; dma is setup
; enable DMA channel 2  RECV DMA
        call    rx_dma_on

        mov     rx_out,0
        mov     end_flag,0
; set up the next address
record_loop:
        mov     dx,wr_clr_byte_ptr      ; init flag t  low byte
        out     dx,al
        jmp     $+2
```

```
; how many words are there in the receive buffer?
        mov     dx,dma_6_address   ; get RX in
        in      al,dx
        mov     cl,al
        jmp     $+2
        in      al,dx
        mov     ch,al
        jmp     $+2

        mov     dx,wr_clr_byte_ptr      ; init flag to low byte
        out     dx,al
        jmp     $+2

; check to see if the low byte rolled over
        mov     dx,dma_6_address
        in      al,dx
        cmp     cl,al
        je      read_ok
        mov     cl,al
        in      al,dx
        mov     ch,al
read_ok:
        mov     ax,rx_out
        shr     ax,1                ; words
        add     ax,rx_dma_ala16
        sub     cx,ax
        jns     pos_diff
        add     cx,( rx_buf_len / 2 )
pos_diff:
;       shr     ax,1                ; word count
        cmp     cx,800h                     ; 2k words
        jge     save_it

        cmp     end_flag,0
        jne     record_loop

        mov     ah,1
        int     16h
        jnz     end_record

        test    main_flags,b3               ; ignore loop loss
        jnz     record_loop

        test    main_flags,b4               ; loop loss?
        jz      record_loop
end_record:
        mov     end_flag,0ffh
        jmp     short rec rd_loop

save_it:
```

```
        push    ds
        m v     cx,1000h              ; 4k bytes
        mov     bx,handle
        mov     dx,rx_ ut
        mov     ah,040h
        mov     ds,rx_sample_segment
        int     21h
        pop     ds
        mov     ax,rx_out
        add     ax,1000h
        cmp     ax,rx_buf_len
        jne     no_rollover
        xor     ax,ax
no_rollover:
        mov     rx_out,ax
        cmp     end_flag,0
        jne     end_record_dma
        jmp     record_loop

end_record_dma:
; disable DMA channel 2 RECV DMA
        call    rx_dma_off

        mov     bx,handle             ; close the file
        mov     ah,03eh
        int     21h

        ret

error_out:
        mov     ah,09h
        int     21h
        ret

RECORD_MSG   ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
PLAYBACK_MSG        PROC  NEAR
.data
        out_msg             db     'msgl.dat',0
        bad_open      db    cr,lf,'Bad file open',cr,lf,'$'
.code
        mov     ah,03dh                    ; open file
        xor     al,al                 ; read access
        int     21h
        jnc     file_open
;       lea     dx,bad_open
;       mov     ah,09h
;       int     21h
```

```
        ret
file_open:
        mov     handle,ax

        1 a     si,init_aic_voice ; tx 9600 rx 9600
        call    init_aic
        call    init_dma

; dma is setup
        mov     tx_in_ptr,0
playback_loop:
        mov     ah,1
        int     16h
        jz      no_abort
        jmp     abort_pb
no_abort:
        mov     dx,wr_clr_byte_ptr      ; init flag to low byte
        out     dx,al
        jmp     $+2

        mov     dx,dma_5_address
        in      al,dx
        mov     cl,al
        jmp     $+2
        in      al,dx
        mov     ch,al
        jmp     $+2

        mov     dx,wr_clr_byte_ptr      ; init flag to low byte
        out     dx,al
        jmp     $+2

; check for low byte rollover
        mov     dx,dma_5_address
        in      al,dx
        cmp     al,cl
        je      tx_address_ok
        mov     cl,al
        jmp     $+2
        in      al,dx
        mov     ch,al
        jmp     $+2

tx_address_ok:
        mov     ax,tx_in_ptr      ; calculate the tx buffer address
        shr     ax,1        ; word address
        add     ax,tx_dma_ala16
        sub     ax,cx
        jns     p s_diff2
        add     ax,( tx_buf_len / 2 )
```

```
p s_diff2:
;       shr     ax,1                ; word count
        cmp     ax,800h                     ; less than 2K words in the buffer?
        jg      playback_1 op

; file the tx buffer with 2K words of samples
        mov     ah,03fh                     ; file read
        mov     bx,handle
        mov     cx,1000h            ; 4K bytes
        mov     dx,tx_in_ptr
        push    ds
        mov     ds,tx_sample_segment
        int     21h
        pop     ds

        push    ax
; enable DMA channel 1  TX DMA
        call    tx_dma_on
        pop     ax

        cmp     ax,0
        je      file_end
        add     tx_in_ptr,1000h             ; adjust input pointer
        cmp     tx_in_ptr,tx_buf_len
        jne     playback_loop

        mov     tx_in_ptr,0
        jmp     short playback_loop


file_end:
        mov     bx,tx_in_ptr        ; calculate the tx buffer address
        shr     bx,1        ; word address
        add     bx,tx_dma_ala16

wait_end_loop:
; wait for tx_in_ptr and the DMA 5 address to be the same
        mov     dx,wr_clr_byte_ptr          ; init flag to low byte
        out     dx,al
        jmp     $+2

        mov     dx,dma_5_address
        in      al,dx
        mov     cl,al
        jmp     $+2
        in      al,dx
        mov     ch,al
        jmp     $+2

        mov     dx,wr_clr_byte_ptr          ; init flag to low byte
```

```
        out     dx,al
        jmp     $+2

 ; check for low byte rollover
        mov     dx,dma_5_address
        in      al,dx
        cmp     al,cl
        je      tx_address_ok2
        mov     cl,al
        jmp     $+2
        in      al,dx
        mov     ch,al
        jmp     $+2

tx_address_ok2:
        cmp     bx,cx
        jne     wait_end_loop


abort_pb:
; disable DMA channel 1 TX DMA
        call    tx_dma_off

;       call    speaker_off

        mov     bx,handle               ; close the file
        mov     ah,03eh
        int     21h

        clc
        ret


PLAYBACK_MSG        ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
COMM_MODE     PROC    NEAR

comm_loop:
   IFE board
;       mov     cx,20000
;here:
;       loop    here
        call    tx1224
        call    demod
   ENDIF
        m v     ah,1            ; any keys hit?
        int     16h
        jz      check_receive
```

```
        jmp     got_key

check_receive:
        test    main_flags,b3       ; ignore lo p current?
        jnz     chk_dbox_mode

        test    main_flags,b4
        jz      chk_dbox_mode
        jmp     dbox_check

chk_dbox_mode:
    IFE board
        test    main_flags,b0
        jnz     data_ok
        cmp     baud_count,300      ; 1.5 seconds
        jle     comm_loop     ; blow off data for 1.5 seconds
        or      main_flags,b0
        mov     rx_char_in,offset rx_char_buf_start
        mov     rx_char_out,offset rx_char_buf_start
data_ok:
    ENDIF
        test    recv_flags,b3       ; are we in display box mode?
        jz      comm_loop

        mov     si,rx_char_out      ; check for receive chars
        cmp     si,rx_char_in
        je      comm_loop

        lodsb
        cmp     si,offset rx_char_buf_end
        jne     save_char_out
        mov     si,offset rx_char_buf_start
save_char_out:
        mov     rx_char_out,si

        mov     bx,5b20h            ; ' '
; do parity checking
        test    main_flags,b10
        jz      no_parity
        test    main_flags,b9
        jz      check_even_odd
        test    main_flags,b8
        jnz     check_mark
        test    al,80h
        jz      good_receive
        mov     bx,3545h
        jmp     short good_receive
check_mark:
        test    al,80h
        jnz     g od_receive
```

```
        mov    bx,3545h
        jmp    short good_receive

check_even_ dd:
; even or  dd
        test   main_flags,b8
        jz     check_even
        cmp    al,0
        jpo    good_receive
        mov    bx,3545h
        jmp    short good_receive
check_even:
        cmp    al,0
        jpe    good_receive
        mov    bx,3545h

good_receive:                          ; if parity is wrong turn.. flash parity
        mov    es,display_segment
        mov    di,70
        mov    [es:di],bx
        and    al,7fh
no_parity:
        call   screen_out
        jmp    comm_loop

got_key:
        mov    ah,0
        int    16h

        cmp    ax,F1
        jne    check_f2

        test   recv_flags,b3      ; check if we are in display box mode
        jnz    comm_loop_jmp

        or     recv_flags,08h     ; turn off the dbox while changing vid modes
        call   dbox_address
        and    recv_flags,0fff7h
        jmp    comm_loop

check_f2:
        cmp    ax,F2
        jne    check_parity

        test   recv_flags,b3
        jnz    go_dbox

        or     recv_flags,08h
        m v    al,vid_mode ; restore the initial vide  m de
        mov    ah,0
```

```
        int   10h
        call  restore_screen
comm_lo p_jmp:
        jmp   comm_loop

go_dbox:
        cmp   dbox_ok,0
        je    comm_loop_jmp       ; display does not support graphics
        call  save_screen
        call  init_dbox
        and   recv_flags,0fff7h
        jmp   comm_loop

check_parity:
        cmp   ax,ALT_P
        jne   check_ascii

        call  new_parity
        jmp   comm_loop

check_ascii:
        cmp   al,0          ; ASCII ?
        je    check_exit

; set up the correct parity
        test  main_flags,b10
        jz    send_it

        test  main_flags,b9
        jnz   force_it
        test  main_flags,b8
        jnz   odd_parity
        cmp   al,0          ; set parity bits
        jpe   send_it
        or    al,80h
        jmp   short send_it
odd_parity:
        cmp   al,0          ; set parity bits
        jpo   send_it
        or    al,80h
        jmp   short send_it

force_it:                   ; mark or space parity
        and   al,7fh
        test  main_flags,b8
        jz    send_it
        or    al,80h

send_it:
; put th  key into the transmit buffer
```

```
        mov     es,ds_segment
        cli
        mov     di,tx_char_in
        stosb
        cmp     di,offset tx_char_buf_end
        jne     save_di
        lea     di,tx_char_buf_start
save_di:
        cmp     di,tx_char_out    ; is the buffer full?
        je      loop_end    ; yes so don't update the pointer
        mov     tx_char_in,di
        sti

check_exit:
        cmp     ax,F10
        je      dbox_check        ; F10
loop_end:
        sti
        jmp     comm_loop

dbox_check:
        test    recv_flags,b3     ; are we data mode ?
        jnz     exit

        or      recv_flags,08h
        mov     al,vid_mode ; restore the initial video mode
        mov     ah,0
        int     10h

exit:
        call    tx_dma_off
        call    rx_dma_off
        cli
        mov     tx_vector,offset nul_routine
        mov     recv_vector,offset nul_routine
        sti
        ret

COMM_MODE    ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
SET_AIC_BANDS      PROC   NEAR

; set up the AIC
        lea     si,init_aic_tx96_rx96
        test    tx_flags,b0
        jnz     tx96
        lea     si,init_aic_tx48_rx48
        test    recv_flags,b0
```

```
        jz      init_interface
        lea     si,init_aic_tx48_rx96
        jmp     sh rt init_interface
tx96:
        test    recv_flags,b0
        jnz     init_interface
        lea     si,init_aic_tx96_rx48
init_interface:
        call    init_aic
        ret

SET_AIC_BANDS       ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
TX_DMA_OFF   PROC   NEAR

   IF board
; disable DMA channels 1
        mov     dx,wr_single_mask
        mov     al,00000101b                ; mask channel 1
        out     dx,al
        and     main_flags,NOT b2
   ENDIF

        ret

TX_DMA_OFF   ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
RX_DMA_OFF   PROC   NEAR

   IF board
; disable DMA channels 2
        mov     dx,wr_single_mask
        mov     al,00000110b                ; mask channel 2
        out     dx,al
   ENDIF

        ret

RX_DMA_OFF   ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
TX_DMA_ON    PROC   NEAR

   IF b ard
        test    main_flags,b2
```

```
        jnz    already_on

    ; enable DMA channels 1
        mov    dx,wr_single_mask
        m v    al,00000001b              ; unmask channel 1
        out    dx,al
        or     main_flags,b2

    already_on:
      ENDIF
        ret

    TX_DMA_ON   ENDP
    ;
    ;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
    ;
    RX_DMA_ON   PROC  NEAR

      IF board
    ; enable DMA channels 2
        mov    dx,wr_single_mask
        mov    al,00000010b              ; unmask channel 2
        out    dx,al
      ENDIF

        ret

    RX_DMA_ON   ENDP
    ;
    ;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
    ;
    ANSWERING_MACHINE PROC  NEAR
    .data
        record_file db    'msgl.dat',0
        announce_file     db    'announce.dat',0
    .code
        test   main_flags,b5
        jz     yes_answer

        call   speaker_on

        lea    dx,announce_file
        call   playback_msg

        call   speaker_off
        ret


    yes_answer:
        call   off_hook
```

```
        call   speaker_off

        mov    ax,50
        call   init_timer

wait_for_timer:
        test   recv_flags,b5
        jz     wait_for_timer

        lea    si,outgoing_msg
        call   window_flip

        lea    dx,out_msg
        call   playback_msg

        mov    freq,tone_1500
        mov    ax,100                    ; 1/2 second
        call   send_tones

        lea    si,outgoing_msg
        call   window_flip

        call   setup_loop_current

        lea    si,recording_msg
        call   window_flip

        lea    dx,record_file
        call   record_msg

        lea    si,recording_msg
        call   window_flip

        call   on_hook

        lea    bx,record_file
        inc    byte ptr [bx+3]

        ret

ANSWERING_MACHINE ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
ORIGINATE_MODE_INIT      PROC   NEAR
   IF board
      and    tx_flags,0fffeh           ; tx low
       r     recv_flags,1h             ; recv_high
   ELSE
;      r     tx_flags,1          ; tx high
```

```
;       or      recv_flags,1                    ; rx high
        and     tx_flags,0fffeh
        and     recv_flags,0fffeh
    ENDIF

        call    init_comm_screen

        and     main_flags,NOT b0
        call    init_tx
        call    init_recv

        or      recv_flags,08h                  ; data mode
        cmp     dbox_ok,0
        je      no_dbox
        and     recv_flags,0fff7h
        call    init_dbox
no_dbox:

    IF board
        call    off_hook
        call    speaker_on

        call    set_aic_bands
        call    init_dma

        call    setup_loop_current

        cli
        mov     ax,150
        call    init_timer
        mov     tx_vector,offset tx1224
        mov     recv_vector,offset demod
; enable DMA channel 2  RECV DMA
        call    rx_dma_on
        sti

wait_timer:
        test    recv_flags,b5
        jz      wait_timer
        call    speaker_off
        mov     rx_char_in,offset rx_char_buf_start
        mov     rx_char_out,offset rx_char_buf_start
    ENDIF
        ret
ORIGINATE_MODE_INIT     ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
SETUP_LOOP_CURRENT      PROC    NEAR
```

```
        and    main_flags,NOT( b3 OR b4 )     ; set up loop 1 ss
        mov    dx,modem_b ard
        in     al,dx
        test   al,b0
        jz     got_loop_current
        or     main_flags,b3                  ; ignore loop loss
got_loop_current:
        ret

SETUP_LOOP_CURRENT      ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
NEW_PARITY  PROC  NEAR

        mov    ax,main_flags
        and    ax,0700h
        inc    ah
        and    ah,07h
        cmp    ah,1
        jne    update_parity
        mov    ah,4          ; make sure parity bit is set
update_parity:
        and    main_flags,0f8ffh
        or     main_flags,ax
        call   print_parity
        ret

NEW_PARITY  ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
MESSAGING_SYSTEM  PROC  NEAR
.data
        done          db     0
        phone_number1       db     9,8,2,5,2,4,0,0ffh
;       phone_number1       db     9,2,9,9,8,4,4,0ffh
        file_1              db     'file1.dat',0
        file_2              db     'file2.dat',0
        end_file      db     'file3.dat',0
        file_3              db     'casey.dat',0
        response_msg        db     'msg1.dat',0
                      dw     0ffffh
.code
; first dial the number
        lea    si,phone_number1

        push   si
call_loop:
     IF board
```

```
        call  off_hook
        call  sp aker_on
        mov   ax,2 * 100          ; 2 sec.
        call  init_timer

off_hook_wait:
        test  recv_flags,b5
        jz    off_hook_wait

        pop   si

dial_loop:
        lodsb
        cmp   al,0ffh
        je    dial_done
        xor   ah,ah
        mov   bx,ax
        mov   ax,7
        push  si
        call  dtmf
        pop   si
        jc    dial_done

        mov   ax,7                ; 70 ms
        call  init_timer

inter_digit_wait:
        test  recv_flags,b5
        jz    inter_digit_wait

        jmp   short dial_loop

dial_done:
        comment      !
        call  init_callp
        mov   cx,28
get_ring:
        mov   ah,1
        int   16h
        jnz   key_hit
        push  cx
        call  get_callp
        test  al,1
        jz    wait_ring
        pop   cx
        dec   cx
        jcxz  got_ring
        jmp   sh rt get_ring
wait_ring:
        pop   cx
```

```
        mov   cx,28
        jmp   short get_ring
g t_ring:
; wait for 4 sec nds  f silence
        mov   cx,112
get_silence:
        mov   ah,1
        int   16h
        jnz   key_hit
        push  cx
        call  get_callp
        test  al,1
        jnz   no_silence
        pop   cx
        dec   cx
        jcxz  got_silence
        jmp   short get_silence
no_silence:
        pop   cx
        mov   cx,112
        jmp   short get_silence

got_silence:
        !
        mov   ah,0
        int   16h

        lea   dx,file_1
        call  playback_msg

        call  get_touch_tone

        lea   dx,file_2
        call  playback_msg

        lea   dx,file_3
        call  playback_msg

        lea   dx,end_file
        call  playback_msg

        mov   freq,tone_1500
        mov   ax,100                    ; 1/2 second
        call  send_tones

        call  setup_loop_current

        lea   dx,response_msg
        call  rec rd_msg
```

```
        call   on_hook
     ELSE
key_hit:
     ENDIF
        mov    ah,0
        int    16h
        ret

MESSAGING_SYSTEM  ENDP

        END

.model small
.286
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
;       INTS is the interrupt routines
;
;       This routine contains the basic interrupt driver for the SOFTMODEM.
;       Tx_vector and rx_vector point to the routines to be performed during
;       the interrupt.  This module also contains the ring detect code.
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

        include      equates

        public       softmodem,init_timer,timer_10ms
        public       processed,nul_routine
        public       recv_vector,tx_vector,int_flags
        public       wedge_int,disable_int,ring_detect
        public       ring_state,no_ring_state,timer_reload
        public       timer_tic

        extrn tx_dma_off:near,rx_dma_off:near

        extrn recv_flags:word,main_flags:word

.data
        int_flags    db    ?
;       int_flags.0 = 1 ring detected

        ring_state   dw    ?      ; ring detect state variable
        state_count  db    ?
        cycle_count  db    ?

        old_comint   dd    ?
        recv_vector  dw    ?
        tx_vector    dw    ?

        timer_10ms   dw    ?      ; ten MS timer
```

```
        timer_tic     db      ?     ; interrrupt counter
        timer_reload          db    ?
        processed     db      ?     ; data has been sent or received
        in_int                db    0
.code
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
SOFTMODEM    PROC   NEAR

        pusha                 ; save context
        push   es
        push   ds

        sti
        mov    al,20h
        out    20h,al

        mov    dx,@data
        mov    ds,dx

        cmp    in_int,0
        jne    exit_int

        mov    in_int,0ffh

modem_loop:
        mov    processed,0
        mov    ax,recv_vector
        call   ax
        mov    ax,tx_vector
        call   ax
        cmp    processed,0
        jne    modem_loop

        mov    dx,modem_board
        in     al,dx
        sal    al,4
        and    ax,b4
        or     main_flags,ax           ; if one then will latch it

; ten MS timer routine
        dec    timer_tic
        jnz    timer_done

        mov    al,timer_reload
        mov    timer_tic,al

        dec    timer_10ms
        jnz    timer_done
```

```
        or    recv_flags,20h.
timer_done:
        mov   in_int,0
exit_int:
        pop   ds            ; restore context
        pop   es
        popa

; interrupt exit
        iret

SOFTMODEM   ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
INIT_TIMER  PROC  NEAR

        cli
        mov   timer_10ms,ax
        and   recv_flags,0ffdfh
        mov   al,6
        test  recv_flags,b0
        jnz   high_band
        shr   al,1
high_band:
        mov   timer_tic,al
        mov   timer_reload,al
nul_routine:
        sti
        ret

INIT_TIMER  ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
WEDGE_INT   PROC  NEAR
   IF board
; wedge int 0bh ---- COM 2 INT

        in    al,21h                  ; set interrupt controller chip
        or    al,00001000b            ; disable com 2 int
        out   21h,al

        mov   al,0bh                  ; COM 2 interrrupt
        mov   ah,35h                  ; get current vector
        int   21h
        mov   word ptr old_comint,bx
        mov   w rd ptr old_comint[2],es

        mov   al,0bh
```

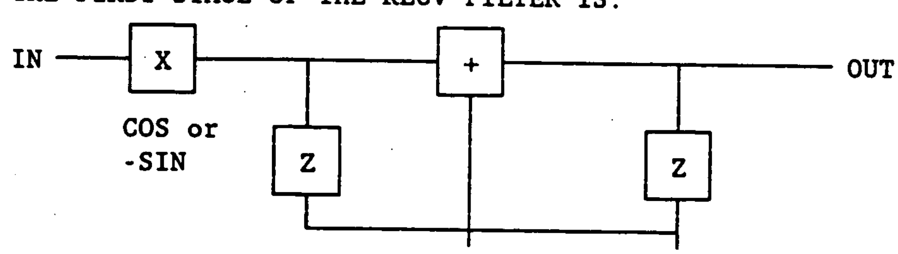
```
        mov   ah,25h                  ;set new vector
        lea   dx,softmodem
        push  ds
        push  cs
        p p   ds
        int   21h
        pop   ds

        in    al,21h                  ; set interrupt controller chip
        and   al,11110111B            ; enable com 2 int
        out   21h,al
     ENDIF
        ret

WEDGE_INT   ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
DISABLE_INT PROC  NEAR
     IF board
        in    al,21h                  ; set interrupt controller chip
        or    al,00001000b            ; disable com 2 int
        out   21h,al

        mov   tx_vector,offset nul_routine
        mov   recv_vector,offset nul_routine

        mov   dx,word ptr old_comint
        mov   ax,word ptr old_comint[2]
        push  ds
        mov   ds,ax
        mov   al,0bh
        mov   ah,25h                  ;set new vector
        int   21h
        pop   ds

        call  rx_dma_off
        call  tx_dma_off
     ENDIF
        ret
DISABLE_INT ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
RING_DETECT PROC  NEAR

        mov   dx,modem_board
        in    al,dx
        mov   bx,ring_state
        call  bx
```

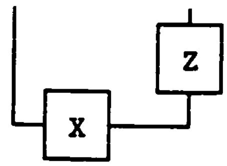
```
        ret

n _ring_state:
        mov   cycle_count,5
        test  al,bl
        jnz   no_ring
        mov   ring_state,offset ringl
no_ring:
        ret

ringl:
        test  al,bl
        jnz   abort_ring                ; got a spike
        mov   state_count,21                  ; 35 ms
        mov   ring_state,offset wait_low      ; low long enough
                                        ; 1.667ms to 3.3ms
        ret
abort_ring:
        mov   ring_state,offset no_ring_state
        ret

wait_low:
; no manual ring check so can be low for 35ms without a problem
; if it stays low for that long then abort the ring and start over
        test  al,bl
        jnz   went_high
        dec   state_count
        jz    abort_ring            ; low for greater than expected
        ret
went_high:
        mov   ring_state,offset wait_high
        mov   state_count,20               ; can't be high more than 33.3ms
        ret

wait_high:
        test  al,bl
        jz    count_cycle
        dec   state_count           ; went high before 5 cycles
        jz    abort_ring
        ret

count_cycle:
        dec   cycle_count
        jz    got_ring
        mov   ring_state,offset ringl
        ret
got_ring:
        m v   state_c unt,105            ; 175ms of no activity f r ring t  be
                                    ; complete
        mov   ring_state,offset wait_end
```

```
        ret

wait_end:
        test  al,bl
        jnz   count_it
        mov   state_count,105
        ret
count_it:
        dec   state_count
        jz    ring_done
        ret
ring_done:
        or    int_flags,1        ; set got ring flag
        mov   ring_state,offset no_ring_state
        ret

RING_DETECT ENDP
        END
.model small
.286
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
;       Receive filter
;
;       This module uses a special filter algorithm for
;       band and phase splitting of the receive samples.
;
;       Receive samples are accumulated at a rate of 9600 per second
;       for high band and 4800 per second for the low band.
;
;       The receive buffer is 8192 words long as is the transmit buffer.
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

        include equates

        public      filter_pq,rx_out,delay_ptr
        public      rx_in,baudlp_vector,save_sl
        public      r_a2_delay,i_a2_delay
        public      buffer_in,buffer_out,interp_a0,interp_al,quad_count
        public      real_buffer,imag_buffer

        extrn agc_average:word
        extrn eqr_delay:word
        extrn eqi_delay:word
        extrn rx_sample_segment
        extrn recv_flags:word,baud_x:word
        extrn agc_speed:word
        extrn agc_mant:word
        extrn temp_x:word,temp_y:word
```

```
        extrn agc_xsube:byte

        delay_length        equ    256

    .data
        rx_out              dw     ?
        rx_in        dw     ?

    ; the following are the baud loop interpolator variables
        baudlp_vector       dw     ?            ; jump for baud loop interpolator

        quad_count   dw     ?            ; update coeff count

        buffer_in    dw     ?
        buffer_out   dw     ?
        real_buffer  dw     4 dup(?)     ; real equalizer input buffer
        imag_buffer  dw     4 dup(?)     ; imaginary buffer

        real_s1             dw     ?            ; interpolator delay lines
        imag_s1             dw     ?

        interp_a0    dw     ?            ; interpolator coefficients
        interp_a1    dw     ?

        old_x dw     ?

    ;   EVENDATA
    ;   rx_samples_start    label word
    ;   rx_sample_buf       dw     8192 dup(?)
    ;   rx_samples_end             label word

    ; REAL DELAY LINES

        delay_ptr    dw     ?

        r_b1_z1             dw     ?
        r_b1_z2             dw     ?

        r_a2_delay_z1       dw     ?
        r_a2_delay   dw     delay_length-1 dup(?)
        r_a2_delay_end0     dw     ?
        r_a2_delay_end1     dw     ?

        r_b2_delay_z1       dw     ?
        r_b2_delay   dw     delay_length-1 dup(?)
        r_b2_delay_end0     dw     ?
        r_b2_delay_end1     dw     ?

        r_a3_delay_z1       dw     ?
        r_a3_delay   dw     delay_length-1 dup(?)
```

```
        r_a3_delay_end0    dw      ?
        r_a3_delay_end1    dw      ?

; IMAGINARY DELAY LINES
        i_a1_z1            dw      ?
        i_b1_z1            dw      ?
        i_b1_z2            dw      ?

        i_a2_delay_z1      dw      ?
        i_a2_delay   dw    delay_length-1 dup(?)
        i_a2_delay_end0    dw      ?
        i_a2_delay_end1    dw      ?

        i_b2_delay_z1      dw      ?
        i_b2_delay   dw    delay_length-1 dup(?)
        i_b2_delay_end0    dw      ?
        i_b2_delay_end1    dw      ?

        i_a3_delay_z1      dw      ?
        i_a3_delay   dw    delay_length-1 dup(?)
        i_a3_delay_end0    dw      ?
        i_a3_delay_end1    dw      ?

.code

FILTER_PQ   PROC   NEAR

; filter and phase split 8 or 16 samples
      mov    ch,4          ; four times through the loop

      mov    es,rx_sample_segment
      mov    si,rx_out     ; filter sample pointer
;     mov    di,equalizer_in    ; equalizer delay line pointer

; filter 4 or 2 samples until we have a sample ready for the second
; stage. Execute the second stage and then do the same for the
; imaginary

filter_loop:

;*******************************************************
;
; THE FIRST STAGE OF THE RECV FILTER IS:
;
```






```
;
;
;
;
;
;                                   -1/4
;
;     COS = 1/4,0,-1/4,0,...     -SIN = 0,-1/4,0,1/4,...
;*****************************************************

        mov     ax,es:[si]
        add     si,4            ; skip the next sample because cos = 0
        sar     ax,2

        test    recv_flags,b0
        jnz     hi_stage1

low_stage1:
        test    ch,1
        jz      no_neg
        neg     ax
no_neg:
        mov     dx,r_b1_z1          ; out1 = 1/4X0 + Z1 - 1/4*Z2
        add     dx,ax
        sar     r_b1_z2,2
        sub     dx,r_b1_z2          ; out1
        mov     r_b1_z2,dx
        add     ax,dx               ; out2 = 1/4X0 + out1 - 1/4*Z1
        sar     r_b1_z1,2
        sub     ax,r_b1_z1
        mov     r_b1_z1,ax          ; first stage pass two done
        jmp     short stage2

hi_stage1:
        mov     bx,ax               ; 1/4 X0 --> BX
        add     ax,r_b1_z1          ; 1/4 X0 + z1
        sar     r_b1_z2,2
        sub     ax,r_b1_z2          ; out1 = 1/4X0 + Z1 + (-1/4*Z2)
        mov     dx,ax               ; dx = out1
        add     ax,bx               ; + 1/4 X0
        sar     r_b1_z1,2
        sub     ax,r_b1_z1          ; out2 = 1/4X0 + out1 + (-1/4*Z1)
        mov     bx,ax               ; bx = out2
        mov     ax,es:[si]          ; get X2 * -1/4
        add     si,4
        sar     ax,2
        neg     ax
        sar     dx,2                ; -1/4 * out1
        neg     dx
        xchg    ax,dx               ; dx = -1/4 * X2
```

```
        add     ax,bx               ; -1/4 X2 + B2/2 = B3
        add     ax,dx               ; out3
        mov     r_b1_z2,ax          ; save in Z2
        add     ax,dx               ; out4 = -1/4X2 +  ut3 - 1/4 ut2
        mov     dx,bx
        sar     dx,2
        sub     ax,dx
        mov     r_b1_z1,ax
        add     ax,bx               ; input to second stage = out4 + out2
        sar     ax,1                ; 1/2

stage2:
        sar     ax,3                ; second stage scalar 1/8

        mov     bx,delay_ptr
        mov     r_a2_delay[bx+2],ax     ; store input into the delay line

        mov     dx,r_a2_delay[bx] ; scalar * OUT + ( 2 * r_a2_z1)
        sal     dx,1
        add     ax,dx
        add     ax,r_a2_delay[bx-2]     ; + r_a2_z2

; calculate OUT1
        add     ax,r_b2_delay[bx] ; add Z1
        mov     dx,r_b2_delay[bx-2]
        sar     dx,1                ; + ( -.5 * B2 )
        sub     ax,dx
        mov     r_b2_delay[bx+2],ax     ; store result into the delay line

        sar     ax,2                ; 1/4
        mov     dx,r_b2_delay[bx] ; + ( 1/2 * Z1 )
        sar     dx,1
        add     ax,dx
        mov     dx,r_b2_delay[bx-2]     ; + Z2/4
        sar     dx,2
        add     ax,dx

        sar     ax,1
        mov     r_a3_delay[bx+2],ax
        add     ax,r_a3_delay[bx-2]     ; + Z3
        mov     temp_x,ax

real_done:
; AX holds the filter and phase split real output
        push    ax
        test    agc_speed,b4
        jz      not_narrow
        sar     ax,3                ; /128 total
not_narrow:
        sar     ax,4                ; /16
```

```
; get the absolute value
        jns     r_positive
        neg     ax
r_positive:
        add     agc_average,ax
        pop     ax

; AGC AX here
        imul    agc_mant
        mov     cl,agc_xsube
        sal     dx,cl

        comment     !
        test    ch,b0
        jnz     no_save
        mov     eqr_delay[di],dx
        jmp     short do_imaginary

no_save:
; do baud loop integrator calculations
        or      dx,dx               ; set the sign bit
        jns     pos_real
        neg     dx
pos_real:
        sar     dx,5                ; /32
        test    ch,b1               ; are we at RX1 or RX0
        jz      add_it
        neg     dx                  ; -RX1
add_it:
        add     baud_sum,dx
        !

        mov     di,dx               ; save in DI

do_imaginary:
; have completed 4 ( or 2 ) input samples for the real delay line.
; Now do the same for the imaginary.


        mov     si,rx_out           ; filter sample pointer

        add     si,2                ; skip the fist sample because sin = 0
        mov     ax,es:[si]
        add     si,2
        sar     ax,2

        test    recv_flags,b0
        jnz     hi_stage1_i

        test    ch,b0
```

```
        jnz     no_neg2
        neg     ax
no_neg2:
        mov     dx,i_a1_z1          ; A1
        mov     i_a1_z1,ax          ; save for the next loop
        add     dx,i_b1_z1
        sar     i_b1_z2,2
        sub     dx,i_b1_z2
        mov     i_b1_z2,dx          ; out1
        add     ax,dx               ; + X0 * 1/4 - OUT
        sar     i_b1_z1,2
        sub     ax,i_b1_z1
        mov     i_b1_z1,ax

; first stage pass two done
        jmp     short stage2_i

hi_stage1_i:
        neg     ax                  ; the first sample is a 0
        mov     dx,ax               ; save for the next loop
        mov     ax,i_a1_z1
        add     ax,i_b1_z1          ; out1 - in_z1 + out_z1 + (-1/4*out_z2)
        sar     i_b1_z2,2
        sub     ax,i_b1_z2
        mov     bx,ax               ; out1
        add     ax,dx               ; out2 - in + out1 + (-1/4*out_z1)
        sar     i_b1_z1,2
        sub     ax,i_b1_z2          ; out2
        add     dx,ax               ; out3 - in + out2 + (-1/4*out1)
        sar     bx,2
        sub     dx,bx               ; out3
        mov     i_b1_z2,dx          ; save out3 in out_z2
        mov     dx,ax               ; dx - out2
        mov     bx,ax
        add     si,2                ; skip sample 2
        mov     ax,es:[si]          ; get sample 3
        add     si,2
        sar     ax,2                ; in3
        mov     i_a1_z1,ax          ; save for next loop
        add     ax,i_b1_z2          ; out3
        sar     bx,2
        sub     ax,bx               ; out4
        mov     i_b1_z1,ax
        add     ax,dx               ; input to second stage - out4 + out2
        sar     ax,1

stage2_i:
        sar     ax,3                ; scaler f r second stage

        mov     bx,delay_ptr
```

```
        mov   i_a2_delay[bx+2],ax     ; store input into the delay line

        mov   dx,i_a2_delay[bx] ; scalar * OUT + ( 2 * i_a2_z1)
        sal   dx,1
        add   ax,dx
        add   ax,i_a2_delay[bx-2]     ; + i_a2_z2

; calculate OUT1
        add   ax,i_b2_delay[bx] ; add Z1
        mov   dx,i_b2_delay[bx-2]
        sar   dx,1              ; + ( -.5 * B2 )
        sub   ax,dx
        mov   i_b2_delay[bx+2],ax     ; store result into the delay line

        sar   ax,2              ; 1/4
        mov   dx,i_b2_delay[bx] ; + ( 1/2 * Z1 )
        sar   dx,1
        add   ax,dx
        mov   dx,i_b2_delay[bx-2]     ; + Z2
        sar   dx,2
        add   ax,dx

        sar   ax,1
        mov   i_a3_delay[bx+2],ax
        add   ax,i_a3_delay[bx-2]     ; + Z3
        mov   temp_y,ax

imag_done:
; AX holds the filter and phase split imaginary output
        push  ax
        test  agc_speed,b4
        jz    wideband_agc
        sar   ax,3              ; /128 total
wideband_agc:
        sar   ax,4              ; /16
; get the absolute value
        jns   i_positive
        neg   ax
i_positive:
        add   agc_average,ax
        pop   ax

; AGC AX here
        imul  agc_mant
        mov   cl,agc_xsube
        sal   dx,cl

        comment     !
        test  ch,b0
        jnz   no_save_i
```

```
        mov     eqi_delay[di],dx
        add     di,2
        jmp     short update_ptr
no_save_i:
; do the baud loop integrator calculations
        or      dx,dx
        jns     pos_imaginary
        neg     dx
pos_imaginary:
        sar     dx,5            ; /32
        test    ch,bl
        jz      add_imaginary       ; RX0 or RX1?
        neg     dx              ; RX1
add_imaginary:
        add     baud_sum,dx
        !

        mov     ax,baudlp_vector
        call    ax

update_ptr:
        add     delay_ptr,2

        mov     rx_out,si
        dec     ch
        jz      baud_time_done
        jmp     filter_loop

baud_time_done:
;       add     equalizer_in,4          ; set for the next baud time
        cmp     si,rx_samples_length
        jne     chk_end_delay

        mov     rx_out,0
chk_end_delay:
        cmp     delay_ptr,(delay_length * 2 )
        jne     no_delay_shift

        mov     delay_ptr,0
; shift the delay lines from the end to the beginning
        mov     ax,r_a2_delay_end0
        mov     r_a2_delay_z1,ax
        mov     ax,r_a2_delay_end1
        mov     r_a2_delay,ax

        mov     ax,r_b2_delay_end0
        mov     r_b2_delay_z1,ax
        mov     ax,r_b2_delay_end1
        m v     r_b2_delay,ax
```

```
        mov   ax,r_a3_delay_end0
        mov   r_a3_delay_z1,ax
        mov   ax,r_a3_delay_end1
        mov   r_a3_delay,ax

; IMAGINARY DELAY LINES
        mov   ax,i_a2_delay_end0
        mov   i_a2_delay_z1,ax
        mov   ax,i_a2_delay_end1
        mov   i_a2_delay,ax

        mov   ax,i_b2_delay_end0
        mov   i_b2_delay_z1,ax
        mov   ax,i_b2_delay_end1
        mov   i_b2_delay,ax

        mov   ax,i_a3_delay_end0
        mov   i_a3_delay_z1,ax
        mov   ax,i_a3_delay_end1
        mov   i_a3_delay,ax

no_delay_shift:
        ret

FILTER_PQ   ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
INTERPOLATOR_ROUTINES   PROC   NEAR

save_s1:
        mov   imag_s1,dx
        mov   real_s1,di
        mov   baudlp_vector,offset save_s0
        ret

save_s0:
; imaginary sample is in DX
; real sample is in DI
        mov   baudlp_vector,offset save_s1
        dec   quad_count
        jz    new_coeff
compute_equalizer:
        mov   bx,buffer_in
; compute imaginary first
        push  cx
        mov   ax,dx
        imul  interp_a0          ; A0 * S0
        mov   cx,dx
        mov   ax,imag_s1
```

```
        imul   interp_a1          ; A1 * S1
        add    cx,dx
        sal    cx,1
        mov    imag_buffer[bx],cx
; compute the real
        mov    ax,di
        imul   interp_a0          ; A0 * S0
        mov    cx,dx
        mov    ax,real_s1         ; A1 * S1
        imul   interp_a1
        add    cx,dx
        sal    cx,1
        mov    real_buffer[bx],cx       ; store in the real buffer
        add    buffer_in,2
        and    buffer_in,07h
        pop    cx
        ret

new_coeff:
        mov    quad_count,32
        mov    ax,old_x
        xor    ax,baud_x
        jns    same_sign          ; if old and new have the same
                                  ; sign then no rollover

; could have rolled over --- or passed through zero so find out
        mov    ax,baud_x          ; if baud_x < .7 then no rollover
        cmp    ax,0
        jge    pos_int
        neg    ax
        jns    pos_int                  ; special case when baud_x = 8000h
        dec    ax
pos_int:
        cmp    ax,5998h           ; .7
        jl     same_sign

        cmp    baud_x,0
        jge    zero_to_one

; compute an extra P
        mov    bx,buffer_in
; compute imaginary first
        push   cx
        push   dx
        mov    ax,dx
        imul   interp_a0          ; A0 * S0
        mov    cx,dx
        mov    ax,imag_s1
        imul   interp_a1          ; A1 * S1
        add    cx,dx
```

```
        sal     cx,1
        mov     imag_buffer[bx],cx
; compute the real
        mov     ax,di
        imul    interp_a0           ; A0 * S0
        mov     cx,dx
        mov     ax,real_s1          ; A1 * S1
        imul    interp_a1
        add     cx,dx
        sal     cx,1
        mov     real_buffer[bx],cx        ; store in the real buffer
        add     buffer_in,2
        and     buffer_in,07h
        pop     dx
        pop     cx

zero_to_one:
        mov     imag_s1,dx
        mov     real_s1,di
        mov     baudlp_vector,offset save_s0
; compute A0 and A1
        mov     ax,baud_x
        mov     old_x,ax
        sar     ax,1
        add     ax,4000h            ; 1/2
        mov     interp_a1,ax
        neg     ax
        add     ax,7fffh
        mov     interp_a0,ax
        ret

same_sign:
; compute A0 and A1
        mov     ax,baud_x
        mov     old_x,ax
        sar     ax,1
        add     ax,4000h            ; 1/2
        mov     interp_a1,ax
        neg     ax
        add     ax,7fffh
        mov     interp_a0,ax
        jmp     compute_equalizer


INTERPOLATOR_ROUTINES   ENDP
        END
.model small
.286
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
```

```
;       Main demodulat r
;
;       This program is the main dem dulat r algorithm for 1200
;       and 2400 baud operation.
;
;       The receive samples are stored in RX_SAMPLE_BUF and are filtered,
;       AGCed, and split into equalizer samples by the file RECVFIL.asm .
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

bleed_tap   macro
        lodsw                   ; 5
        cwd                     ; 2
        and     dl,bl           ; 2
        or      dl,bh           ; 2
        sub     ax,dx           ; 2
        stosw                   ; 3
        endm

absolute    macro

        cwd
        xor     ax,dx
        sub     ax,dx
        sar     ax,5

        endm

        include equates

        public          equalizer_in,recv_flags,demod
        public          agc_average,agc_speed,recv_sample_count
        public          eqr_delay,eqi_delay
        public          init_recv,rx_char_out,rx_char_in
        public          rx_char_buf_start,rx_char_buf_end
        public          dbox_address,baud_count
        public          agc_xsube,agc_mant
        public          temp_x,temp_y,loop2_int,baud_x

        extrn filter_pq:near,save_sl:near
        extrn init_dbox:near,plot_point:near,get_tx_data:near
        extrn buffer_in:word,buffer_out:word
        extrn delay_ptr:word,baudlp_vector
        extrn cosine_table:word,sine_table:word
        extrn rx_out:word,rx_in:word
        extrn i_a2_delay:word,r_a2_delay:word
        extrn ds_segment:word,rx_dma_ala16:word
        extrn tx_flags:w rd
        extrn buffer_in:word,buffer_out:word
        extrn interp_a0:word,interp_al:w rd,quad_count:word
```

```
        extrn real_buffer:word,imag_buffer:word

        extrn vid_mode:byte,x:byte,y:byte
        extrn reverse_table:byt
        extrn processed:byte

        rx_buf_len          equ    8192
        equalizer_length    equ    2048
        Cbeta1                     equ    -3072
        Cbeta2                     equ    1096
        Calpha                     equ    -3072
        receive_low_thresh         equ    0000h
        receive_high_thresh        equ    0000h

.data
        tap_offset   dw     ?
        temp_x             dw     ?
        temp_y             dw     ?

        recv_sample_count dw     ?      ; number of samples per baud time
        processed_cnt      dw     ?

        eqr_delay    dw     equalizer_length dup(?) ; real equalizer delay
        eqr_end      label word
        eqi_delay    dw     equalizer_length dup(?) ; imaginary equalizer
        eqi_end      label word

        real_taps    dw     14 dup(?)
        imaginary_taps     dw     14 dup(?)

        equalizer_in       dw     ?      ; equalizer delay line input pointer
        baud_count   dw     ?      ; increment every baud time

        rzn          dw     ?      ; equalizer real output
        izn          dw     ?      ; eqiulizer imaginary output

        rym          dw     ?      ; rotated equalizer output
        iym          dw     ?

        r_error            dw     ?      ; real error vector
        i_error            dw     ?      ; imaginary error vector

        dec_r        dw     ?      ; closest V22 point - real
        dec_i        dw     ?      ; V22 point - imaginary

        alpha        dw     ?      ; tap update speed

        aren         dw     ?      ; alpha * ren
        aien         dw     ?      ; alpha * ien
```

```
ierr        dw    ? ..  ; counter rotated err r vector imag.

recv_flags  dw    ?
;   bit 0       1 - recv high band
;   bit 1       1 - recv 2400 baud
;   bit 2       1 - got 1200 recv data
;   bit 3       1 - receive data on
;   bit 4       1 - detected 1100 ( S1 )
;   bit 5       1 - 10Ms timer expired
;   bit 6       1 - got energy
;   bit 7       1 - call progress timed out
;   bit 8       1 - looking for the end of the answer tone

phi         dw    ?     ; carrier loop angle
phase_corr  dw    ?     ; phase corrector integrator

cosine            dw    ?     ; cosine(phi)
sine        dw    ?     ; sine(phi)

recv_data   db    ?     ; demodulated data

dbox_routine      dw    ?

s1_counter  db    ?

decision_table    db    0bh
            db    0ah
            db    0dh
            db    0fh
            db    09h
            db    08h
            db    0ch
            db    0eh
            db    06h
            db    04h
            db    00h
            db    01h
            db    07h
            db    05h
            db    02h
            db    03h

prev_y3y2   db    ?
descram_0   db    ?
descram_1_17      dw    ?
data_1200   db    ?

eye_menu    db    '1. equalizer output',cr,lf
            db    '2.  qualiz r 0 input',cr,lf
            db    '3. equalizer 1 input',cr,lf
```

```
                    db      '4.. tap 5',cr,lf
                    db      '5. S1 detector',cr,lf
                    db      '6. Interpolator A1',cr,lf
                    db      '7. PHI',cr,lf
                    db      '8. 1st order baud loop integrator',cr,lf
                    db      '9. 2nd order baud loop integrator',cr,lf,'$'

tap_question        db      cr,lf,'Enter tap number ( 0 - 9, A - D ):','$'

rx_char_in  dw      ?
rx_char_out dw      ?

rx_char_buf_start label byte
rx_char_buf db      2000 dup(?)
rx_char_buf_end   label byte

r_parse_jmp dw      ?
r_parse_data        dw      ?

agc_coeff0  dw      1460h
agc_coeff1  dw      50b7h
agc_coeff2  dw      4f50h
agc_coeff3  dw      27e1h
agc_coeff4  dw      887h

energy_threshold dw     ?
agc_average dw      ?       ; agc sum
old_agc             dw      ?
agc_speed   dw      ?       ; agc countdown
agc_mant    dw      ?
agc_xsube   db      ?

baud_sum    dw      ?
loop2_int   dw      ?
loop2_cnt   db      ?
baud_x              dw      ?

baud_loop2_table db     60
                    db      60
                    db      30
                    db      20
                    db      15
                    db      12
                    db      10
                    db      9
                    db      8
                    db      7
                    db      6
                    db      5
                    db      4
```

```
                    db      3
                    db      2
.code
DEMOD PROC  NEAR

   IF board
      mov    dx,wr_clr_byte_ptr       ; init flag to low byte
      out    dx,al
      jmp    $+2

; how many words are there in the receive buffer?
      mov    dx,dma_6_address   ; get RX in
      in     al,dx
      mov    cl,al
      jmp    $+2
      in     al,dx
      mov    ch,al
      jmp    $+2

      mov    dx,wr_clr_byte_ptr       ; init flag to low byte
      out    dx,al
      jmp    $+2

      mov    dx,dma_6_address
      in     al,dx
      cmp    cl,al
      je     read_ok
      mov    cl,al
      in     al,dx
      mov    ch,al
read_ok:
      mov    ax,rx_out
      shr    ax,1
      add    ax,rx_dma_ala16
      sub    cx,ax
      jns    pos_diff
      add    cx,rx_buf_len
pos_diff:
;     shr    ax,1               ; word count
      cmp    cx,recv_sample_count
      jge    demodulate_it
      ret
   ELSE
      call   get_tx_data
      jnc    demodulate_it            ; data available
      ret
   ENDIF
;****************************************************************************
*
;
```

```
;      DEMODULATION CODE .  ..
;
;***************************************************************************
*
dem dulate_it:
       cmp    cx,processed_cnt  ; more than 1 1/2 baud times samples?
       jle    not_enough_samples      ; this will prevent further calls to
       or     processed,01h           ; demod by the interrrupt
not_enough_samples:
       inc    baud_count
       call   filter_pq         ; filter the next baud times samples
                                ; insert into the equalizer delay lines

equalizer_buf_check:                  ; are there two samples in the
       mov    ax,buffer_in            ; equilizer buffer ?
       sub    ax,buffer_out
       jns    no_adj
       add    ax,08h
no_adj:
       cmp    ax,4
       jge    get_equ
       ret

get_equ:
       mov    di,equalizer_in
       mov    bx,buffer_out

       mov    ax,real_buffer[bx]      ; RX1
       mov    eqr_delay[di],ax
       absolute                 ; take care of the baud loop integrator
       sub    baud_sum,ax

       mov    ax,imag_buffer[bx]      ; IX1
       mov    eqi_delay[di],ax
       absolute
       sub    baud_sum,ax

       add    bx,2
       and    bx,07h
       mov    ax,real_buffer[bx]      ; RX0
       mov    eqr_delay[di+2],ax
       absolute
       add    baud_sum,ax

       mov    ax,imag_buffer[bx]      ; IX0
       mov    eqi_delay[di+2],ax
       absolute
       add    baud_sum,ax

       add     qualizer_in,4
```

```
        add   bx,2
        and   bx,07h
        mov   buffer_ ut,bx

        test  recv_flags,b6
        jnz   got_energy

        mov   ax,baud_count
        and   ax,agc_speed
        jz    energy_check
no_energy:
        jmp   equalizer_full_check
energy_check:
        mov   ax,agc_average
        sub   ax,energy_threshold
        js    no_energy
        or    recv_flags,b6
        mov   baud_count,1
        jmp   short new_level

got_energy:
        mov   ax,baud_count
        and   ax,agc_speed              ; every 4 or 32 baud times
        jz    check_alpha
        jmp   display_box

;****************************************************************************
*
;       AGC code
;****************************************************************************
*

check_alpha:
        cmp   baud_count,100h
        jne   agc_tests
        mov   alpha,800h                ; slow down to 1/16 after 2 sec
agc_tests:
        test  agc_speed,b4
        jz    wideband_agc

; AGC test 1
        mov   ax,old_agc
        sar   ax,1              ; .5
        sub   ax,agc_average            ; new < .5 old then compute all new AGC
        jns   new_level

; AGC test 2
        mov   ax,old_agc
        sar   ax,1
        add   ax,old_agc        ; 1.5  ld
```

```
        sub     ax,agc_average
        jns     wideband_agc                ; if new > 1/5 old then compute new AGC

n w_level:
        mov     ax,agc_average
        mov     old_agc,ax
        jmp     short compute_agc

wideband_agc:
; get ( ALPHA * NEW ) + (( 1 - ALPHA ) * OLD )
; ALPHA = 1/8
        mov     ax,old_agc
        mov     bx,ax
        sar     bx,3                ; 1/8
        sub     ax,bx               ; 7/8 old
        mov     bx,agc_average
        sar     bx,3                ; + 1/8 new
        add     ax,bx
        mov     old_agc,ax

compute_agc:
        mov     agc_average,0
        mov     cl,1
; AX is > 0
; subtract one from cl because the reference is /4 but during the actual
; AGCing of the sample we need a * 2
normalize:
        inc     cl
        test    ax,b14
        jnz     normalize_done
        sal     ax,1
        jmp     short normalize
normalize_done:
        mov     agc_xsube,cl
        push    ax              ; M
        mov     bx,ax
        imul    bx
        sal     dx,1
        push    dx              ; M^2
        mov     ax,bx
        imul    dx
        sal     dx,1
        push    dx              ; M^3
        mov     ax,bx
        imul    dx
        sal     dx,1            ; M^4
        mov     bx,agc_coeff0
        mov     ax,agc_coeff4
        imul    dx              ; A(4) * M^4
        add     bx,dx
```

```
        pop     ax
        imul    agc_c eff3    ; A(3) * M^3
        sub     bx,dx
        pop     ax
        imul    agc_coeff2    ; A(2) * M^2
        add     bx,dx
        pop     ax
        imul    agc_coeff1    ; A(1) * M
        sub     bx,dx
        sal     bx,3          ; * 8 because of equation plus a * 2 because
                              ; of the multiplies and a /2 for reference
        mov     agc_mant,bx

        cmp     baud_count,32       ; slow the AGC down after 32 baud times
        jne     display_box
        mov     agc_speed,1fh

display_box:
        test    recv_flags,b3
        jnz     baud_loop

        mov     ax,dbox_routine
        call    ax
        mov     x,ah
        mov     y,bh
        call    plot_point

;****************************************************************************
*
;****************************************************************************
*

; equation is | RX0 | + | IX0 | - | RX1 | - | IX1 | + | RX2 | + ...
; over eight baud times

baud_loop:
; do first order baud loop every 8 baud times
        mov     ax,baud_count
        and     ax,7h
        jnz     baud_loop2

        cmp     baud_sum,0
        mov     ax,160
        jns     shorten
        neg     ax
shorten:
        add     baud_x,ax

        mov     ax,baud_sum
        mov     baud_sum,0
```

```
        sar     ax,7                    ; /128
        add     loop2_int,ax
        jns     check_upper
        cmp     loop2_int,0f200h
        jge     baud_loop2
        mov     loop2_int,0f200h
        jmp     short baud_loop2
check_upper:
        cmp     loop2_int,0f00h
        jl      baud_loop2
        mov     loop2_int,0effh

baud_loop2:
        dec     loop2_cnt
        jnz     equalizer_output

        mov     ax,loop2_int
        or      ax,ax                   ; set sign bit
        js      add_time
        cmp     ax,0ffh
        jle     get_new_count
        add     baud_x,160
        jmp     short get_new_count

add_time:
        sub     baud_x,160
        neg     ax

get_new_count:
        xor     bh,bh
        mov     bl,ah
        mov     al,baud_loop2_table[bx]
        mov     loop2_cnt,al

equalizer_output:
;**************************************************
;*
;*      equalizer update ( calculate rzn + j izn )
;*
;*      rzn = ( rx * rw ) - ( ix * iw ) summed over all taps
;*      izn = ( rx * iw ) + ( ix * rw )
;*
;**************************************************
        mov     bx,equalizer_in
        lea     si,real_taps

; CALCULATE ( REAL EQUALIZER DELAY 0 - 13 ) * ( REAL TAP 0 - 13 )
        lodsw                           ; rtap0
        imul    word ptr eqr_delay[bx-2]
        m v     cx,dx
```

```
    lodsw                          ; rtap1
    imul  word ptr eqr_delay[bx-4]
    add   cx,dx
    lodsw                          ; rtap2
    imul  word ptr eqr_delay[bx-6]
    add   cx,dx
    lodsw                          ; rtap3
    imul  word ptr eqr_delay[bx-8]
    add   cx,dx
    lodsw                          ; rtap4
    imul  word ptr eqr_delay[bx-10]
    add   cx,dx
    lodsw                          ; rtap5
    imul  word ptr eqr_delay[bx-12]
    add   cx,dx
    lodsw                          ; rtap6
    imul  word ptr eqr_delay[bx-14]
    add   cx,dx
    lodsw                          ; rtap7
    imul  word ptr eqr_delay[bx-16]
    add   cx,dx
    lodsw                          ; rtap8
    imul  word ptr eqr_delay[bx-18]
    add   cx,dx
    lodsw                          ; rtap9
    imul  word ptr eqr_delay[bx-20]
    add   cx,dx
    lodsw                          ; rtap10
    imul  word ptr eqr_delay[bx-22]
    add   cx,dx
    lodsw                          ; rtap11
    imul  word ptr eqr_delay[bx-24]
    add   cx,dx
    lodsw                          ; rtap12
    imul  word ptr eqr_delay[bx-26]
    add   cx,dx
    lodsw                          ; rtap13
    imul  word ptr eqr_delay[bx-28]
    add   cx,dx


; CALCULATE ( IMAGINARY EQUALIZER DELAY 0 - 13 ) * ( IMAGINARY TAP 0 - 13 )
; si already pointing to the imaginary taps
    lodsw                          ; itap0
    imul  word ptr eqi_delay[bx-2]
    sub   cx,dx
    lodsw                          ; itap1
    imul  word ptr eqi_delay[bx-4]
    sub   cx,dx
    lodsw                          ; itap2
```

```
        imul  word ptr eqi_delay[bx-6]
        sub   cx,dx
        l dsw                          ; itap3
        imul  word ptr eqi_delay[bx-8]
        sub   cx,dx
        lodsw                          ; itap4
        imul  word ptr eqi_delay[bx-10]
        sub   cx,dx
        lodsw                          ; itap5
        imul  word ptr eqi_delay[bx-12]
        sub   cx,dx
        lodsw                          ; itap6
        imul  word ptr eqi_delay[bx-14]
        sub   cx,dx
        lodsw                          ; itap7
        imul  word ptr eqi_delay[bx-16]
        sub   cx,dx
        lodsw                          ; itap8
        imul  word ptr eqi_delay[bx-18]
        sub   cx,dx
        lodsw                          ; itap9
        imul  word ptr eqi_delay[bx-20]
        sub   cx,dx
        lodsw                          ; itap10
        imul  word ptr eqi_delay[bx-22]
        sub   cx,dx
        lodsw                          ; itap11
        imul  word ptr eqi_delay[bx-24]
        sub   cx,dx
        lodsw                          ; itap12
        imul  word ptr eqi_delay[bx-26]
        sub   cx,dx
        lodsw                          ; itap13
        imul  word ptr eqi_delay[bx-28]
        sub   cx,dx

        sal   cx,2                     ; adjust for the multiply plus 1/2 tap
        mov   rzn,cx

        lea   si,real_taps

; CALCULATE ( IMAGINARY equalIZER DELAY 0 - 13 ) * ( REAL TAP 0 - 13 )
        lodsw                          ; rtap0
        imul  word ptr eqi_delay[bx-2]
        mov   cx,dx
        lodsw                          ; rtap1
        imul  word ptr eqi_delay[bx-4]
        add   cx,dx
        l dsw                          ; rtap2
        imul  word ptr eqi_delay[bx-6]
```

```
        add   cx,dx
        lodsw                          ; rtap3
        imul  word ptr eqi_delay[bx-8]
        add   cx,dx
        l dsw                          ; rtap4
        imul  word ptr eqi_delay[bx-10]
        add   cx,dx
        lodsw                          ; rtap5
        imul  word ptr eqi_delay[bx-12]
        add   cx,dx
        lodsw                          ; rtap6
        imul  word ptr eqi_delay[bx-14]
        add   cx,dx
        lodsw                          ; rtap7
        imul  word ptr eqi_delay[bx-16]
        add   cx,dx
        lodsw                          ; rtap8
        imul  word ptr eqi_delay[bx-18]
        add   cx,dx
        lodsw                          ; rtap9
        imul  word ptr eqi_delay[bx-20]
        add   cx,dx
        lodsw                          ; rtap10
        imul  word ptr eqi_delay[bx-22]
        add   cx,dx
        lodsw                          ; rtap11
        imul  word ptr eqi_delay[bx-24]
        add   cx,dx
        lodsw                          ; rtap12
        imul  word ptr eqi_delay[bx-26]
        add   cx,dx
        lodsw                          ; rtap13
        imul  word ptr eqi_delay[bx-28]
        add   cx,dx

; CALCULATE ( REAL EQUALIZER DELAY 0 - 13 ) * ( IMAGINARY TAP 0 - 13 )
; si already pointing to the imaginary taps
        lodsw                          ; itap0
        imul  word ptr eqr_delay[bx-2]
        add   cx,dx
        lodsw                          ; itap1
        imul  word ptr eqr_delay[bx-4]
        add   cx,dx
        lodsw                          ; itap2
        imul  word ptr eqr_delay[bx-6]
        add   cx,dx
        lodsw                          ; itap3
        imul  w rd ptr eqr_delay[bx-8]
        add   cx,dx
```

```
        lodsw                   ; itap4
        imul  word ptr eqr_delay[bx-10]
        add   cx,dx
        lodsw                   ; itap5
        imul  word ptr eqr_delay[bx-12]
        add   cx,dx
        lodsw                   ; itap6
        imul  word ptr eqr_delay[bx-14]
        add   cx,dx
        lodsw                   ; itap7
        imul  word ptr eqr_delay[bx-16]
        add   cx,dx
        lodsw                   ; itap8
        imul  word ptr eqr_delay[bx-18]
        add   cx,dx
        lodsw                   ; itap9
        imul  word ptr eqr_delay[bx-20]
        add   cx,dx
        lodsw                   ; itap10
        imul  word ptr eqr_delay[bx-22]
        add   cx,dx
        lodsw                   ; itap11
        imul  word ptr eqr_delay[bx-24]
        add   cx,dx
        lodsw                   ; itap12
        imul  word ptr eqr_delay[bx-26]
        add   cx,dx
        lodsw                   ; itap13
        imul  word ptr eqr_delay[bx-28]
        add   cx,dx

        sal   cx,2              ; adjust for the multiply
        mov   izn,cx

phase_rotation:
;****************************************************
;*
;*    phase rotation
;*
;*    rym = ( rzn * cosphi ) - ( izn * sinphi )
;*    iym = ( rzn * sinphi ) + ( izn * cosphi )
;*
;****************************************************
        mov   ax,rzn
        imul  cosine
        mov   bx,dx
        mov   ax,izn
        imul  sine
        sub   bx,dx
        sal   bx,2          ; sine and cosine are 1/2 scale
```

```
        mov    rym,bx

        mov    ax,rzn
        imul   sine
        mov    bx,dx
        mov    ax,izn
        imul   cosine
        add    bx,dx
        sal    bx,2          ; sine and cosine are 1/2 scale
        mov    iym,bx

;**************************************************
;*
;*     derive the error vector and the v22 point
;*
;*     error vector --- r_error + j i_error
;*     v22 point    --- dec_r   + j dec_i
;*
;**************************************************
        xor    bx,bx
        mov    ax,rym
        test   recv_flags,bl
        jnz    decision_2400
        jmp    decision_1200

decision_2400:
        or     ax,ax
        js     r_negative_24

        mov    bl,2
        cmp    ax,( 44 * 256 )
        jge    big_positive_24

; real is less than 44
        sub    ax,( 22 * 256 )
        mov    r_error,ax

        mov    dec_r,( 22 * 256 )
        jmp    short i_decision

big_positive_24:
; real is above 44
        sub    ax,( 66 * 256 )
        mov    r_error,ax

        mov    dec_r,( 66 * 256 )
        inc    bx
        jmp    short i_decision

r_negative_24:
```

```
        xor     bl,bl
        cmp     ax,( -44 * 256 )
        jle     big_negative_24

        add     ax,( 22 * 256 )
        mov     r_error,ax

        mov     dec_r,( -22 * 256 )
        inc     bx
        jmp     short i_decision

big_negative_24:
        add     ax,( 66 * 256 )
        mov     r_error,ax

        mov     dec_r,( -66 * 256 )

i_decision:
        mov     ax,iym

        or      ax,ax
        js      i_negative_24

        cmp     ax,( 44 * 256 )
        jge     imag_big

; imaginary is less than 44
        sub     ax,( 22 * 256 )
        mov     i_error,ax

        mov     dec_i,( 22 * 256 )
        or      bl,8
        jmp     short read_decision

imag_big:
; real is above 44
        sub     ax,( 66 * 256 )
        mov     i_error,ax

        mov     dec_i,( 66 * 256 )
        or      bl,0ch
        jmp     short read_decision

i_negative_24:
        cmp     ax,( -44 * 256 )
        jle     imag_lil

        add     ax,( 22 * 256 )
        m v     i_error,ax
```

```
        mov   dec_i,( -22 * 256 )
        or    bl,4
        jmp   short read_decisi n

imag_lil:
        add   ax,( 66 * 256 )
        mov   i_error,ax

        mov   dec_i,( -66 * 256 )
        jmp   short read_decision

decision_1200:
        or    ax,ax
        js    r_neg_1200

        sub   ax,( 49 * 256 )
        mov   r_error,ax

        mov   dec_r,( 49 * 256 )
        mov   bl,3
        jmp   short i_1200

r_neg_1200:
        add   ax,( 49 * 256 )
        mov   r_error,ax

        mov   dec_r,( -49 * 256 )
        xor   bl,bl

i_1200:
        mov   ax,iym
        or    ax,ax
        js    i_neg_1200

        sub   ax,( 49 * 256 )
        mov   i_error,ax

        mov   dec_i,( 49 * 256 )
        or    bl,0ch
        jmp   short read_decision

i_neg_1200:
        add   ax,( 49 * 256 )
        mov   i_error,ax

        mov   dec_i,( -49 * 256 )

read_decision:
        mov   al,d cisi n_tabl [bx]
        mov   recv_data,al
```

```
;*************************************************
;*
;*   counter rotate th  err r vector and multiply
;*   by alpha
;*
;*   equation = alpha * (( r_error + j i_error ) * ( cosphi - j sinphi))
;*
;*   aren = alpha * (( r_error * cosphi ) + ( i_error * sinphi ))
;*   aien = alpha * (( i_error * cosphi ) - ( r_error * sinphi ))
;*
;*************************************************
      mov   cx,alpha          ; CX = alpha

      mov   ax,r_error
      imul  cosine
      mov   bx,dx
      mov   ax,i_error
      imul  sine
      add   bx,dx
      sal   bx,1
      mov   ax,bx
      imul  cx
      sal   dx,1
      mov   aren,dx

      mov   ax,i_error
      imul  cosine
      mov   bx,dx
      mov   ax,r_error
      imul  sine
      sub   bx,dx
      sal   bx,1
      mov   ax,bx
      imul  cx
      sal   dx,1
      mov   aien,dx

;*************************************************
;*
;*    tap update loop
;*
;*   equation = rw - (( rx * aren ) + ( ix * aien ))
;*              iw - (( rx * aien ) - ( ix * aren ))
;*
;*************************************************

; SI = Real delay line
; DI = Imaginary delay line
; BX = aren
; CX = aien
```

```
        mov    ax,baud_count ..
        and    ax,0fh
        jz     bleed
        jmp    d _tap_update

bleed:
        push   ds
        pop    es
        lea    si,real_taps
        mov    di,si
        mov    bl,0f8h
        mov    bh,04h

    REPT 28
        bleed_tap
    ENDM
        jmp    rotate

do_tap_update:
        mov    cx,aien
        mov    bx,aren
        mov    si,equalizer_in
        mov    di,si
        add    si,offset eqr_delay
        add    di,offset eqi_delay

; real tap 0
        mov    ax,ds:[si-2]              ; eqr
        imul   bx                      ; * aren
        mov    bp,dx
        mov    ax,ds:[di-2]              ; eqi
        imul   cx                      ; * aien
        add    dx,bp
        sal    dx,1
        sub    real_taps[0],dx

; real tap 1
        mov    ax,ds:[si-4]              ; eqr
        imul   bx                      ; * aren
        mov    bp,dx
        mov    ax,ds:[di-4]              ; eqi
        imul   cx                      ; * aien
        add    dx,bp
        sal    dx,1
        sub    real_taps[2],dx

; real tap 2
        m v    ax,ds:[si-6]              ; eqr
        imul   bx                      ; * aren
        mov    bp,dx
```

```
        mov   ax,ds:[di-6]             ; eqi
        imul  cx                   ; * aien
        add   dx,bp
        sal   dx,1
        sub   real_taps[4],dx

; real tap 3
        mov   ax,ds:[si-8]             ; eqr
        imul  bx                   ; * aren
        mov   bp,dx
        mov   ax,ds:[di-8]             ; eqi
        imul  cx                   ; * aien
        add   dx,bp
        sal   dx,1
        sub   real_taps[6],dx

; real tap 4
        mov   ax,ds:[si-10]            ; eqr
        imul  bx                   ; * aren
        mov   bp,dx
        mov   ax,ds:[di-10]            ; eqi
        imul  cx                   ; * aien
        add   dx,bp
        sal   dx,1
        sub   real_taps[8],dx

; real tap 5
        mov   ax,ds:[si-12]            ; eqr
        imul  bx                   ; * aren
        mov   bp,dx
        mov   ax,ds:[di-12]            ; eqi
        imul  cx                   ; * aien
        add   dx,bp
        sal   dx,1
        sub   real_taps[10],dx

; real tap 6
        mov   ax,ds:[si-14]            ; eqr
        imul  bx                   ; * aren
        mov   bp,dx
        mov   ax,ds:[di-14]            ; eqi
        imul  cx                   ; * aien
        add   dx,bp
        sal   dx,1
        sub   real_taps[12],dx

; real tap 7
        mov   ax,ds:[si-16]            ; eqr
        imul  bx                   ; * aren
        m v   bp,dx
```

```
        mov   ax,ds:[di-16]          ; eqi
        imul  cx                   ; * aien
        add   dx,bp
        sal   dx,1
        sub   real_taps[14],dx

; real tap 8
        mov   ax,ds:[si-18]          ; eqr
        imul  bx                   ; * aren
        mov   bp,dx
        mov   ax,ds:[di-18]          ; eqi
        imul  cx                   ; * aien
        add   dx,bp
        sal   dx,1
        sub   real_taps[16],dx

; real tap 9
        mov   ax,ds:[si-20]          ; eqr
        imul  bx                   ; * aren
        mov   bp,dx
        mov   ax,ds:[di-20]          ; eqi
        imul  cx                   ; * aien
        add   dx,bp
        sal   dx,1
        sub   real_taps[18],dx

; real tap 10
        mov   ax,ds:[si-22]          ; eqr
        imul  bx                   ; * aren
        mov   bp,dx
        mov   ax,ds:[di-22]          ; eqi
        imul  cx                   ; * aien
        add   dx,bp
        sal   dx,1
        sub   real_taps[20],dx

        comment      !
; real tap 11
        mov   ax,ds:[si-24]          ; eqr
        imul  bx                   ; * aren
        mov   bp,dx
        mov   ax,ds:[di-24]          ; eqi
        imul  cx                   ; * aien
        add   dx,bp
        sal   dx,1
        sub   real_taps[22],dx

; real tap 12
        mov   ax,ds:[si-26]          ; eqr
        imul  bx                   ; * aren
```

```
        mov    bp,dx
        mov    ax,ds:[di-26]            ; eqi
        imul   cx                   ; * aien
        add    dx,bp
        sal    dx,1
        sub    real_taps[24],dx

; real tap 13
        mov    ax,ds:[si-28]            ; eqr
        imul   bx                   ; * aren
        mov    bp,dx
        mov    ax,ds:[di-28]            ; eqi
        imul   cx                   ; * aien
        add    dx,bp
        sal    dx,1
        sub    real_taps[26],dx
        !

; Process the imaginary taps
;                iw - (( rx * aien ) - ( ix * aren ))

; imaginary tap 0
        mov    ax,ds:[di-2]             ; eqi
        imul   bx                   ; * aren
        mov    bp,dx
        mov    ax,ds:[si-2]             ; eqr
        imul   cx                   ; * aien
        sub    dx,bp
        sal    dx,1
        sub    imaginary_taps[0],dx

; imaginary tap 1
        mov    ax,ds:[di-4]             ; eqi
        imul   bx                   ; * aren
        mov    bp,dx
        mov    ax,ds:[si-4]             ; eqr
        imul   cx                   ; * aien
        sub    dx,bp
        sal    dx,1
        sub    imaginary_taps[2],dx

; imaginary tap 2
        mov    ax,ds:[di-6]             ; eqi
        imul   bx                   ; * aren
        mov    bp,dx
        mov    ax,ds:[si-6]             ; eqr
        imul   cx                   ; * aien
        sub    dx,bp
        sal    dx,1
        sub    imaginary_taps[4],dx
```

```
; imaginary tap 3
        m v     ax,ds:[di-8]              ; eqi
        imul    bx                    ; * aren
        mov     bp,dx
        m v     ax,ds:[si-8]              ; eqr
        imul    cx                    ; * aien
        sub     dx,bp
        sal     dx,1
        sub     imaginary_taps[6],dx

; imaginary tap 4
        mov     ax,ds:[di-10]             ; eqi
        imul    bx                    ; * aren
        mov     bp,dx
        mov     ax,ds:[si-10]             ; eqr
        imul    cx                    ; * aien
        sub     dx,bp
        sal     dx,1
        sub     imaginary_taps[8],dx

; imaginary tap 5
        mov     ax,ds:[di-12]             ; eqi
        imul    bx                    ; * aren
        mov     bp,dx
        mov     ax,ds:[si-12]             ; eqr
        imul    cx                    ; * aien
        sub     dx,bp
        sal     dx,1
        sub     imaginary_taps[10],dx

; imaginary tap 6
        mov     ax,ds:[di-14]             ; eqi
        imul    bx                    ; * aren
        mov     bp,dx
        mov     ax,ds:[si-14]             ; eqr
        imul    cx                    ; * aien
        sub     dx,bp
        sal     dx,1
        sub     imaginary_taps[12],dx

; imaginary tap 7
        mov     ax,ds:[di-16]             ; eqi
        imul    bx                    ; * aren
        mov     bp,dx
        mov     ax,ds:[si-16]             ; eqr
        imul    cx                    ; * aien
        sub     dx,bp
        sal     dx,1
        sub     imaginary_taps[14],dx
```

```
; imaginary tap 8
     mov    ax,ds:[di-18]              ; eqi
     imul   bx                    ; * aren
     m v    bp,dx
     mov    ax,ds:[si-18]              ; eqr
     imul   cx                    ; * aien
     sub    dx,bp
     sal    dx,1
     sub    imaginary_taps[16],dx

; imaginary tap 9
     mov    ax,ds:[di-20]              ; eqi
     imul   bx                    ; * aren
     mov    bp,dx
     mov    ax,ds:[si-20]              ; eqr
     imul   cx                    ; * aien
     sub    dx,bp
     sal    dx,1
     sub    imaginary_taps[18],dx

; imaginary tap 10
     mov    ax,ds:[di-22]              ; eqi
     imul   bx                    ; * aren
     mov    bp,dx
     mov    ax,ds:[si-22]              ; eqr
     imul   cx                    ; * aien
     sub    dx,bp
     sal    dx,1
     sub    imaginary_taps[20],dx

     comment      !
; imaginary tap 11
     mov    ax,ds:[di-24]              ; eqi
     imul   bx                    ; * aren
     mov    bp,dx
     mov    ax,ds:[si-24]              ; eqr
     imul   cx                    ; * aien
     sub    dx,bp
     sal    dx,1
     sub    imaginary_taps[22],dx

; imaginary tap 12
     mov    ax,ds:[di-26]              ; eqi
     imul   bx                    ; * aren
     mov    bp,dx
     mov    ax,ds:[si-26]              ; eqr
     imul   cx                    ; * aien
     sub    dx,bp
     sal    dx,1
     sub    imaginary_taps[24],dx
```

```
; imaginary tap 13
     mov   ax,ds:[di-28]          ; eqi
     imul  bx                   ; * aren
     mov   bp,dx
     mov   ax,ds:[si-28]          ; eqr
     imul  cx                   ; * aien
     sub   dx,bp
     sal   dx,1
     sub   imaginary_taps[26],dx
     !

;*************************************************
;*
;*   rotate the imaginary eye to the real plane
;*
;*   equation = ( rym + j iym ) * ( dec_r - j dec_i )
;*   ierr = j (( iym * dec_r ) - ( rym * dec_i )) * 2
;*
;*************************************************
rotate:
; IERR is used in the phase corrector
     mov   ax,iym
     imul  dec_r
     mov   bx,dx
     mov   ax,rym
     imul  dec_i
     sub   bx,dx
     sal   bx,2          ; adjust for the multiply and add a gain of 2
     mov   ierr,bx

;**************************************************************************
*
;*
;*    new phase corrector (carrier pll update) aln 9/23/88
;*
;*    equations:
;*          phcor = phcor + (ierr * Cbeta1)
;*          phi = phi + (phcor*Cbeta2 + ierr*Calpha)
;*        Cbeta1= input coefficient to loop's 2nd order integrator
;*     Cbeta2= output coefficient of 2nd int for frequency lock limit
;*     Calpha= 1st order loop coefficent. 2nd order term is not nested
;*     inside 1st order term in this configuration.
;*     NOTE: Cbeta1 and Calpha must be negative values for stable loop
;**************************************************************************
*

phase_update:
;* for V.22bis mode only. lo p parameters can be determined with PLL2.BAS
;* current choices f r variables are:
```

```
        mov   ax,Cbetal
        imul  bx          ; ierr * Cbetal
        sal   dx,1
        add   phase_corr,dx     ; phase_corr + ( ierr * Cbetal )
        mov   ax,Calpha
        imul  bx          ; ierr * Calpha
        mov   bx,dx
        mov   ax,Cbeta2
        imul  phase_corr  ; phase_corr * Cbeta2
        add   bx,dx
        sal   bx,1
        add   bx,phi
        mov   phi,bx

; sine and cosine routine
        mov   bl,bh
        xor   bh,bh
        sal   bx,1
        mov   ax,cosine_table[bx]
        mov   cx,sine_table[bx]
        sar   ax,1
        mov   cosine,ax
        sar   cx,1
        mov   sine,cx

;***************************************************************************
*
;***************************************************************************
*

sl_detect:
        mov   bx,equalizer_in
        mov   ax,eqr_delay[bx-2]      ; z0
        sub   ax,eqr_delay[bx-10]     ; z4
        jns   band_pass_pos
        neg   ax
band_pass_pos:
        sub   ax,(20 * 256)
        js    add_one
        sub   sl_counter,4
        jns   data_decode
        mov   sl_counter,0
add_one:
        inc   sl_counter
        cmp   sl_counter,20
        jl    data_decode
        mov   sl_counter,20
        or    recv_flags,b4
```

```
;*****************************************************************************
*
;*****************************************************************************
*

data_decode:
; do differential decode
     xor   ax,ax
     mov   al,recv_data
     ror   ax,2
     mov   bl,al        ; save top two bits
     sub   al,prev_y3y2
     mov   prev_y3y2,bl
; gray decode
     test  al,bl
     jnz   no_gray
     xor   al,1
no_gray:
     and   al,3

     test  recv_flags,b2          ; is there 1200 baud data from
     jnz   combine_1200_data ; the prev.baud time

     rol   ax,2               ; restore b1,b0

     test  recv_flags,b1          ; are we at 2400 baud?
     jnz   descramble_4

     and   al,0ch
     mov   data_1200,al
     or    recv_flags,4
     jmp   equalizer_full_check

combine_1200_data:
     and   recv_flags,0fffbh
     or    al,data_1200
     xor   ah,ah
descramble_4:
     mov   bx,ax
     xor   dx,dx
     mov   al,reverse_table[bx]    ; put oldest bit in ax.0
     mov   dh,al              ; save for delay line
     mov   bx,descram_1_17
     xor   ax,bx
     shr   bx,3
     xor   ax,bx
     shr   bx,1
      r    bh,descram_0
     and   ax,0fh                 ; descrambled data
     rol   dx,5               ; dx.0 is th  last bit
```

```
        and     bx,1fffh
        or      bh,dh
        mov     descram_1_17,bx
        mov     descram_0,0
        test    dx,b0
        jz      no_bit_0
        mov     descram_0,10h
no_bit_0:
        comment      !
        cmp     al,09h
        jg      hex_nums
        or      al,30h
        jmp     short print_it
hex_nums:
        sub     al,0ah
        add     al,'A'
print_it:
        mov     dl,al
        mov     ah,02h
        int     21h
        !

receive_parser:
        cmp     r_parse_jmp,0
        je      check_for_start

        mov     bx,r_parse_jmp
        jmp     bx

check_for_start:
        cmp     ax,0fh
        jne     got_start_bit
        jmp     equalizer_full_check

got_start_bit:
        mov     r_parse_data,ax
        mov     r_parse_jmp,offset parse_8
        jmp     equalizer_full_check

parse_8:
        shl     ax,4
        or      r_parse_data,ax
        mov     r_parse_jmp,offset parse_12
        jmp     equalizer_full_check

parse_12:
        mov     r_parse_jmp,0       ; default
        shl     ax,8
        or      ax,r_parse_data     ; last three baud times of data
        mov     cx,3          ; number of bits left in the high nybble
```

```
        shr     ax,1
        jnc     got_start
        dec     cx
        shr     ax,1
        jnc     got_start
        dec     cx
        shr     ax,1
        jnc     got_start
        shr     ax,1
        dec     cx
got_start:                      ; the parsed character is in al
        mov     di,rx_char_in
        mov     es,ds_segment
        stosb
        cmp     di,offset rx_char_buf_end
        jne     no_rollover
        mov     di,offset rx_char_buf_start
no_rollover:
        cmp     di,rx_char_out      ; is the buffer full
        je      no_update
        mov     rx_char_in,di
no_update:
        jcxz    equalizer_full_check
        dec     cx
        jcxz    test_one_bit
        dec     cx
        jcxz    test_two_bits
test_three_bits:
        test    ah,1h
        jz      insert_bit
        test    ah,2h
        jz      insert_bit          ; AH = xxxxxd01
        test    ah,4h
        jnz     equalizer_full_check
insert_bit:
        shl     ah,1                ; AH = xxxxxdd0
        or      ah,1h
        mov     al,ah
        xor     ah,ah
        mov     r_parse_data,ax
        mov     r_parse_jmp,offset parse_8
        jmp     equalizer_full_check

test_one_bit:
        test    ah,1h
        jnz     equalizer_full_check
        mov     r_parse_data,07h  ; AH = xxxxxxx0
        mov     r_parse_jmp,offset parse_8
        jmp     short equalizer_full_check
```

```
test_tw _bits:
        test   ah,1h
        jz     insert_tw _bits          ; AH = xxxxxxd0
        test   ah,2h
        jnz    equalizer_full_check
                                ; AH = xxxxxx01
insert_two_bits:
        shl    ah,2
        or     ax,3h
        mov    al,ah
        xor    ah,ah
        mov    r_parse_data,ax
        mov    r_parse_jmp,offset parse_8

equalizer_full_check:
        cmp    equalizer_in,( equalizer_length * 2 )
        jne    not_full

; shift the last eight samples in the equalizer delay line to the beginning
; and reset the input pointer.

        mov    es,ds_segment
        mov    di,offset eqr_delay
;       mov    si,offset ( eqr_end - 16 )
        mov    si,offset ( eqr_end - 24 )
        mov    cx,12
        rep    movsw

        mov    di,offset eqi_delay
;       mov    si,offset ( eqi_end - 16 )
        mov    si,offset ( eqi_end - 24 )
        mov    cx,12
        rep    movsw

        mov    equalizer_in,24

not_full:
        jmp    equalizer_buf_check

DEMOD ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
INIT_RECV    PROC   NEAR

        mov    agc_average,0
        mov    agc_speed,3h             ; 4 baud times
        mov    equalizer_in,24          ; 12 int  the delay line at start
        mov    rx_ ut,0
        m v    rx_in,0
```

```
        mov   delay_ptr,0
        mov   alpha,1000h

        mov   recv_sample_count,16
        mov   processed_cnt,24
        mov   energy_threshold,receive_high_thresh
        test  recv_flags,b0
        jnz   clr_taps
        mov   recv_sample_count,8
        mov   processed_cnt,12
        mov   energy_threshold,receive_low_thresh
clr_taps:
; clear the taps
        push  ds
        pop   es
        lea   di,real_taps
        mov   cx,28
        xor   ax,ax
        rep   stosw

        mov   baud_count,ax

; zero the baud loop out
        mov   baud_sum,ax
        mov   loop2_int,ax
        mov   loop2_cnt,10
        mov   buffer_in,ax
        mov   buffer_out,ax
        mov   interp_a1,ax
        mov   interp_a0,7fffh
        mov   quad_count,32
        mov   baudlp_vector,offset save_s1

        mov   dbox_routine,offset send_eye
        mov   tap_offset,10
;       mov   dbox_routine,offset tap_routine
        mov   real_taps+12,0100000000000000b        ; center tap to 1/2

        mov   rx_char_in,offset rx_char_buf
        mov   rx_char_out,offset rx_char_buf

        mov   r_parse_jmp,0

        ret

INIT_RECV    ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
DBOX_ROUTINES      PROC   NEAR
```

```
send_ey :
        mov    ax,rym
        m v    bx,iym
        ret

equ_in0:
        mov    bx,equalizer_in
        mov    ax,eqr_delay[bx-2]
        mov    bx,eqi_delay[bx-2]
        ret

equ_in1:
        mov    bx,equalizer_in
        mov    ax,eqr_delay[bx-4]
        mov    bx,eqi_delay[bx-4]
        ret

tap_routine:
        mov    bx,tap_offset
        mov    ax,real_taps[bx]
        mov    bx,imaginary_taps[bx]
        ret

sl_routine:
        mov    bx,aien
        sal    bx,6
        mov    ax,aren
        sal    ax,6
;       mov    ah,al
        ret

p_routine:
        mov    bx,interp_al
        mov    ax,baud_count
        mov    ah,al
        ret

phi_routine:
        mov    bx,sine
        mov    ax,cosine
        ret

baud_loop1_routine:
        mov    bx,baud_sum
        sal    bx,3
        mov    ax,baud_count
        mov    ah,al
        ret

baud_l op2_routine:
```

```
        mov   bx,l op2_int
        sal   bx,2
        mov   ax,baud_count
        mov   ah,al
        ret

send_temp:
        mov   ax,temp_x
        mov   bx,temp_y
        ret

baud_loop_routine:
        mov   bx,equalizer_in
        mov   bx,eqr_delay[bx-2]
        mov   ax,baud_count
        mov   ah,al
        ret

DBOX_ROUTINES      ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
DBOX_ADDRESS       PROC   NEAR

        mov   al,vid_mode ; restore the initial video mode
        mov   ah,0
        int   10h

        mov   dx,offset eye_menu
        mov   ah,09h
        int   21h

get_key_in:
        mov   ah,0          ; get a key
        int   16h

        cmp   al,31h
        jne   chk_2

        mov   dbox_routine,offset send_eye
        jmp   address_done

chk_2:
        cmp   al,32h
        jne   chk_3

        mov   dbox_routine,offset equ_in0
        jmp   short address_done

chk_3:
```

```
        cmp   al,33h
        jne   chk_4

        m v   dbox_routine,offset equ_inl
        jmp   short address_done

chk_4:
        cmp   al,34h
        jne   chk_5

get_again:
        mov   ah,09
        mov   dx,offset tap_question
        int   21h

        mov   ah,0
        int   16h

        mov   ah,'0'
        cmp   al,'0'
        jl    get_again
        cmp   al,'9'+1
        jb    got_num
        and   al,0dfh              ; convert to upper case
        cmp   al,'A'
        jb    get_again
        cmp   al,'D'
        ja    get_again
        mov   ah,'A'-10

got_num:
        sub   al,ah
        sal   al,1
        xor   ah,ah
        mov   tap_offset,ax

        mov   dbox_routine,offset tap_routine
        jmp   short address_done

chk_5:
        cmp   al,35h
        jne   chk_6
        mov   dbox_routine,offset sl_routine
        jmp   short address_done

chk_6:
        cmp   al,36h
        jne   chk_7
        mov   dbox_routin ,offset p_routine
        jmp   short address_done
```

```
chk_7:
      cmp   al,37h
      jne   chk_8

      mov   dbox_routine,offset phi_routine
      jmp   short address_done

chk_8:
      cmp   al,38h
      jne   chk_9

      mov   dbox_routine,offset baud_loop1_routine
      jmp   short address_done

chk_9:
      cmp   al,39h
      je    send_loop2
      jmp   get_key_in
send_loop2:
      mov   dbox_routine,offset baud_loop2_routine

address_done:
      call  init_dbox

      ret

DBOX_ADDRESS      ENDP
      END


.model small
.286

;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
;     DBOX --- Display box routines
;
;     DBOX initializes the screen to 640 X 350 graphics mode and
;     draws a picture of an oscilloscope display.  The routine plot_point
;     is then used to place a point on the oscilloscope.
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

      include     equates
BLACK       equ   0
BLUE        equ   1
GREEN       equ   2
CYAN        equ   3
RED         equ   4
```

```
MAGENTA                 equ     5
BROWN           equ     6
LIGHTGRAY       equ     7
DARKGRAY        equ     8
LIGHTBLUE       equ     9
LIGHTGREEN      equ     10
LIGHTCYAN       equ     11
LIGHTRED        equ     12
LIGHTMAGENTA            equ     13
YELLOW                  equ     14
WHITE           equ     15

        public          init_dbox,plot_point,x,y


set_color       macro new_color

        push    ax
        push    dx
        mov     dx,3ceh                 ; clear mode 0 using set/reset
        xor     al,al
        mov     ah,new_color            ; init SET/RESET to color
        out     dx,ax
        pop     dx
        pop     ax

        endm


scope_point struc
center                  dw      0ffffh
xy              dw      0               ; the point
bit_position            db      0

center_lg       db      0               ; light gray
up_lg           db      0
down_lg                 db      0
side_center_lg          db      0
side_up_lg      db      0
side_down_lg            db      0

center_dg       db      0               ; dark gray
up_dg           db      0
down_dg                 db      0
side_center_dg          db      0
side_up_dg      db      0
side_down_dg            db      0

center_b        db      0               ; blu
up_b            db      0
```

```
down_b              db     0
side_center_b       db     0
side_up_b     db    0
side_d wn_b db      0

scope_point ends

.data

      color         db     ?

; defines the display box
      left          dw     ?
      top           dw     ?
      right         dw     ?
      bottom               dw     ?
      vert_top      dw     ?
      vert_dif      dw     ?

; x = horizontal point    y = vertical
      x             db     ?
      y             db     ?

      delta_x              db     ?
      delta_y              db     ?
      point_ptr     dw     ?

      point0               scope_point <>
      point1               scope_point <>
      point2               scope_point <>
      point3               scope_point <>
      point4               scope_point <>
      point5               scope_point <>
      point6               scope_point <>
      point7               scope_point <>

      dbox_menu_start      label byte
      dbox_menu     db     ' F1  --- Display Menu',cr,lf
                    db     ' F2  --- Terminal Mode',cr,lf
                    db     ' F10 --- Hangup'
      dbox_menu_end        label byte

      dbox_label_start     label byte
      dbox_label    db     'SOFTMODEM DISPLAY BOX'
      dbox_label_end       label byte


.c d
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

```
;
INIT_DBOX    PROC   NEAR

      mov    cx,8
      call   zero_points
      mov    point_ptr,0

      call   scope        ; display the oscilloscope

;     mov    dx,3ceh
;     mov    ax,1005h
;     out    dx,ax

      mov    dx,3ceh            ; enable set/reset all planes
      mov    ax,0001h
      out    dx,ax

      mov    ax,1300h
      mov    bh,0
      mov    bl,(YELLOW XOR LIGHTGRAY OR 80h )
      mov    cx,dbox_menu_end-dbox_menu_start
      mov    dx,0000h
      push   ds
      pop    es
      mov    bp,offset dbox_menu
      int    10h

      mov    cx,dbox_label_end-dbox_label_start
      mov    dx,171dh
      mov    bp,offset dbox_label
      int    10h

      mov    dx,3ceh            ; enable set/reset all planes
      mov    ax,0f01h
      out    dx,ax

      mov    color,YELLOW
      ret

INIT_DBOX    ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
SQUARE       PROC   NEAR

      push   ax
      push   bx
      push   cx
      push   dx
      push   di
```

```
        mov   dx,3ceh          ; clear mode 0 using set/reset
        xor   al,al
        mov   ah,color    ; init SET/RESET to color
        out   dx,ax

        mov   bx,top           ; up two from the corner
        sub   bx,2
        mov   ax,80       ; convert top to byte address
        imul  bx


        mov   di,ax
        mov   ax,left
        shr   ax,3        ; /8
        dec   ax          ; left corner begins one byte earlier
        add   di,ax
        mov   vert_top,di ; save for double line

        mov   dx,03ceh    ; enable right two pixels
        mov   ax,0308h
        out   dx,ax

; put in the two pixels that make up the upper left corner of the box
        mov   bl,es:[di]
        stosb
        push  di          ; di is the start of the solid line
        add   di,79       ; go to next line
        mov   bl,es:[di]
; second line
        stosb
        pop   di


        mov   ax,0ff08h   ; enable all pixels  dx = 03ceh
        out   dx,ax

        mov   cx,right    ; get the number of bytes across
        sub   cx,left
        shr   cx,3        ; /8
        mov   vert_dif,cx ; save for double line
        inc   vert_dif

        push  di
        push  cx
        rep   stosb       ; top line
        pop   cx
        pop   di

        push  cx
        add   di,80
```

```
        rep   stosb        ; next line
        pop   cx

        mov   dx,03ceh     ; enable left tw  pixels
        mov   ax,0c008h
        out   dx,ax

; put in the two pixels that make up the upper right corner of the box
        mov   dl,es:[di]
        stosb
        sub   di,81
        mov   dl,es:[di]
; second line
        stosb

        mov   bx,bottom
        inc   bx           ; one past the bottom of the box
        mov   ax,80        ; get the bottom left point
        imul  bx
        mov   di,ax
        mov   ax,left
        shr   ax,3
        dec   ax           ; one byte left of the box
        add   di,ax

        mov   dx,03ceh     ; enable right two pixels
        mov   ax,0308h
        out   dx,ax

        mov   dl,es:[di]
        stosb
        add   di,79        ; next line
        mov   dl,es:[di]
; second line
        stosb

        mov   dx,03ceh     ; enable all the pixels
        mov   ax,0ff08h
        out   dx,ax

        push  di           ; second bottom line
        push  cx
        rep   stosb
        pop   cx
        pop   di

        sub   di,80        ; second bottom line
        rep   st sb

        mov   dx,03ceh     ; enabl  left two pixels
```

```
        mov   ax,0c008h
         ut   dx,ax

        mov   dl,es:[di]
        stosb
        add   di,79         ; one line down
        mov   dl,es:[di]
; second line
        stosb

; set up the map mask register to RED and also the set/reset register to reset

; the 0 and 3 planes

        mov   dx,03ceh      ; enable pixels 1 and 0
        mov   ax,0308h
        out   dx,ax

; to change the pixels to a new color must enable them in
; the MAP MASK register.  Use SET/RESET reg to clear or set the new color.
; Use the bit mask to enable the correct bits

;       mov   dx,3c4h              ; set map mask to the three planes
;                           ; that need to change
;       mov   ax,0f02h      ; color - 4 ... RED
;       out   dx,ax

;       mov   dx,3ceh              ; ENABLE SET/RESET 3 planes that are zero
;       mov   ax,0f01h
;       out   dx,ax

;       mov   ah,color
;       xor   al,al         ; set the SET/RESET register to clear
;       out   dx,ax         ; the enabled planes

        add   vert_top,160         ; point to first line under top/left
        mov   di,vert_top
        mov   bx,vert_top
        mov   ax,bottom     ; line count
        sub   ax,top
        inc   ax
        mov   cx,ax
        add   bx,vert_dif ; get first line under top/right
        push  cx
vert_loop1:
        mov   dl,es:[di]
        mov   es:[di],al
        add   di,80
        loop  vert_loop1
```

```
        m v     dx,03ceh      ; change bit mask t  the tw  left bits
        m v     ax,0c008h
        out     dx,ax

        pop     cx
        mov     al,03h
vert_loop2:
        mov     dh,es:[bx]
        mov     es:[bx],al
        add     bx,80
        loop    vert_loop2

        pop     di
        pop     dx
        pop     cx
        pop     bx
        pop     ax

        ret

SQUARE          ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
HORIZ_LINE      PROC    NEAR

        push    ax
        push    bx
        push    cx
        push    dx
        push    di

        mov     dx,03ceh      ; enable all the pixels
        mov     ax,0ff08h
        out     dx,ax

        mov     ah,color      ; enable SET/RESET to the color
        xor     al,al
        out     dx,ax

        mov     ax,0f01h      ; enable SET/RESET all planes
        out     dx,ax

        mov     ax,80         ; convert top to byte address
        imul    top
        mov     di,ax
        mov     ax,left
        shr     ax,3          ; /8
        add     di,ax
```

```
        mov   ax,right    ; get the number of bytes across
        sub   ax,left
        shr   ax,3        ; /8
        mov   cx,ax       ; byte count

        rep   stosb       ; draw the line

        pop   di
        pop   dx
        pop   cx
        pop   bx
        pop   ax

        ret

HORIZ_LINE  ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
VERT_LINE   PROC  NEAR

        push  ax
        push  bx
        push  cx
        push  dx
        push  di

        mov   dx,03ceh    ; enable the left most pixel
        mov   ax,08008h
        out   dx,ax

        mov   ah,color    ; enable SET/RESET to the color
        xor   al,al
        out   dx,ax

        mov   ax,0f01h    ; enable SET/RESET all planes
        out   dx,ax

        mov   ax,80       ; convert top to byte address
        imul  top
        mov   di,ax
        mov   ax,left
        shr   ax,3
        add   di,ax

        mov   cx,bottom   ; get the number of bytes down
        sub   cx,top
        inc   cx

vert_loop3:
```

```
        mov     dl,es:[di]
        mov     es:[di],al
        add     di,80
        loop    vert_loop3

        mov     dx,03ceh        ; enable all the pixels
        mov     ax,0ff08h
        out     dx,ax

        pop     di
        pop     dx
        pop     cx
        pop     bx
        pop     ax

        ret

VERT_LINE       ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
SCOPE PROC      NEAR

        push    ax
        push    bx
        push    cx
        push    dx
        push    di
        push    es

        mov     ax,16           ; 640 x 350 graphics mode
        int     10h

        mov     dx,0a000h       ; segment for diaplay adapter
        mov     es,dx

; This routine changes the color of the screen using SET/RESET REGISTERS

        mov     dx,3ceh                 ; enable set/reset all planes
        mov     ax,0f01h
        out     dx,ax

        xor     al,al           ; clear mode 0 using set/reset
        mov     ah,LIGHTGRAY
        out     dx,ax

        mov     ax,1005h        ; set to mode 0
        out     dx,ax

; CLS
```

```
        xor     di,di
        xor     ax,ax           ; write t  each location
        mov     cx,14000
        rep     stosw

        comment     !
; insert a grid
        mov     dx,03ceh        ; enable all the pixels
        mov     ax,08008h
        out     dx,ax

        mov     ah,RED                  ; enable SET/RESET to the color
        xor     al,al
        out     dx,ax

        mov     ax,0f01h        ; enable SET/RESET all planes
        out     dx,ax

        mov     cx,28000
        mov     di,0
vert_loop4:
        mov     dl,es:[di]
        stosb
        loop    vert_loop4
        !

; center the display box on the screen
        mov     left,64
        mov     right,64+512
        mov     top,48
        mov     bottom,48+255

        mov     color,BLUE
        call    square

        mov     bx,bottom
        inc     bx
        sub     bx,top
        shr     bx,3            ; 1/8
        mov     cx,7
        push    top             ; save top for the square
        mov     color,DARKGRAY

line_loop:
        add     top,bx
        cmp     cx,4            ; skip the center line
        je      no_line1
        call    horiz_line      ; line uses t p,left,right
no_line1:
        loop    line_loop
```

```
        pop     top
        push    left            ; save left
        mov     bx,right
        sub     bx,left
        shr     bx,3            ; 1/8
        mov     cx,7
vline_loop:
        add     left,bx
        cmp     cx,4            ; skip the center line
        je      no_line2
        call    vert_line       ; vline uses top, bottom, and left
no_line2:
        loop    vline_loop

; write the center lines
        pop     left
        mov     color,BLUE
        push    top
        mov     bx,top
        mov     ax,bottom
        sub     ax,top
        sar     ax,1            ; 1/2
        add     ax,bx
        mov     top,ax
        call    horiz_line
        pop     top

        mov     bx,left
        mov     ax,right
        sub     ax,bx
        sar     ax,1            ; 1/2
        add     ax,bx
        push    left
        mov     left,ax
        call    vert_line
        pop     left

        pop     es
        pop     di
        pop     dx
        pop     cx
        pop     bx
        pop     ax

        ret

SCOPE ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
```

```
PLOT_POINT  PROC  NEAR

        push  ax
        push  bx
        push  cx
        push  dx
        push  di
        push  es

        mov   dx,0a000h    ; segment for diaplay adapter
        mov   es,dx

        call  restore_old

        mov   ax,127
        sub   al,y
        add   ax,top
        mov   bx,80
        imul  bx
        mov   di,ax          ; row byte count

        mov   ax,128
        add   al,x
        sal   ax,1           ; 512 pixels accross
        add   ax,left
; divide by eight and leave the remainder in dl
        mov   dl,al
        and   dl,7h
        shr   ax,3           ; /8
        add   di,ax          ; offset to correct byte

; upon entry di has the pixel address and dl has the bit position
        call  save_new      ; save the new one
        add   point_ptr,2
        and   point_ptr,0fh

        set_color color

; write the new pixel
; dl has the bit count in the correct byte
        xor   bh,bh
        mov   bl,dl
        mov   ch,dl          ; save ch = 0,2,4,6
        mov   ah,center_0[bx]

        mov   al,8
        mov   dx,03ceh      ; enable the pixel
        out   dx,ax

        mov   cl,es:[di]    ; cent r line
```

```
        mov   es:[di],cl

        mov   ah,center_0[bx+1]
        out   dx,ax

        add   di,80
        cmp   y,-128
        je    skip_bottom
        mov   cl,es:[di]   ; lower line
        mov   es:[di],cl

skip_bottom:
        sub   di,160
        cmp   y,127
        je    skip_top
        mov   cl,es:[di]   ; upper line
        mov   es:[di],cl

skip_top:
; If the center pixel is near the left or right side then we
; must fill in the pixels in the adjoining byte
; Because we only plot on even pixels...ch can equal 0,2,4,6
; pixels 2 and 4 are in the center of the byte so no extra work.

        cmp   x,-128              ; if on the left edge of the display box...skip
        je    not_left_side

        cmp   ch,0
        jne   not_left_side

        mov   ah,00000001b        ; setup right most pixel
        out   dx,ax

        dec   di             ; one left of upper row
        cmp   y,127
        je    skip_top1
        mov   cl,es:[di]   ; upper line
        mov   es:[di],cl
skip_top1:
        add   di,160
        cmp   y,-128
        je    skip_bottom1
        mov   cl,es:[di]   ; lower line
        mov   es:[di],cl
skip_bottom1:
        sub   di,80
        mov   ah,00000011b
         ut   dx,ax
        m v   cl,es:[di]   ; center line
        mov   es:[di],cl
```

```
        jmp    short n t_right_side

not_left_side:
        cmp    x,127          ; if on right edge....skip
        je     not_right_side

        cmp    ch,6
        jne    not_right_side

        cmp    y,-128
        je     not_right_side

        mov    ah,10000000b        ; setup left most pixel
        out    dx,ax

        add    di,81          ; one row down one right
        mov    cl,es:[di]     ; lower line
        mov    es:[di],cl

not_right_side:
        pop    es
        pop    di
        pop    dx
        pop    cx
        pop    bx
        pop    ax

        ret

.data

center_0    db    11100000b    ; first line is center row of the dot
            db    11000000b    ; second is the upper and lower lines

center_2    db    11111000b
            db    01110000b

center_4    db    00111110b
            db    00011100b

center_6    db    00001111b
            db    00000111b

.code
PLOT_POINT  ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
RESTORE_OLD PROC  NEAR
```

```
        push  ax
        push  bx
        push  cx
        push  dx
        push  di
        push  si

        lea   si,points
        add   si,point_ptr
        mov   ax,ds:[si]
        mov   si,ax
        lodsw
        mov   di,ax

        lodsw                 ; get the point
        mov   cx,ax           ; scope point

        lodsb
        xor   bh,bh
        mov   bl,al           ; bit position

        set_color LIGHTGRAY
        call  do_color

        set_color DARKGRAY
        call  do_color

        set_color BLUE
        call  do_color

no_point:
        pop   si
        pop   di
        pop   dx
        pop   cx
        pop   bx
        pop   ax

        ret

.data
points        dw    offset point0
        dw    offset point1
        dw    offset point2
        dw    offset point3
        dw    offset point4
        dw    offset point5
        dw    offset p int6
        dw    offset p int7
```

```
.code
RESTORE_OLD ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
DO_COLOR     PROC  NEAR
; upon entry:
;      DI - center byte address
;      SI - center byte color content address
;      CH - x
;      CL - y
;      BL - bit position within byte

       push  di            ; save center location
       push  si

; check all six sides for any dots.... if not exit
       push  si
       push  cx
       xor   ah,ah
       mov   cx,6
any_color_loop:
       lodsb
       cmp   al,0
       jne   yes_restore
       loop  any_color_loop

       pop   cx
       pop   si            ; leave si at next address
       jmp   restore_exit

yes_restore:
       pop   cx
       pop   si

       mov   dx,03ceh      ; graphics 1 and 2 address

       lodsb               ; center pixels
       cmp   al,0
       je    no_center

       mov   ah,al
       mov   al,08h
       out   dx,ax

       mov   al,es:[di]    ; center restore
       mov   es:[di],al

no_center:
       sub   di,80         ; upper line
```

```
        lodsb

        cmp   al,0
        je    no_up

        cmp   cl,127          ; upper edge?
        je    no_up

        mov   ah,al
        mov   al,08h
        out   dx,ax         ; enable the LIGHTGRAY pixels

        mov   al,es:[di]    ; upper restore
        mov   es:[di],al

no_up:
        add   di,160
        lodsb

        cmp   al,0
        je    no_down

        cmp   cl,-128
        je    no_down

        mov   ah,al
        mov   al,08h
        out   dx,ax         ; enable the LIGHTGRAY pixels

        mov   al,es:[di]    ; lower restore
        mov   es:[di],al

no_down:
        lodsb               ; side center byte
        cmp   bl,0          ; left edge
        je    left_3_bytes

        cmp   bl,6
        jne   restore_exit
; since the old dot is at location 6 just restore the right center byte
        sub   di,79         ; one line up, one right

        cmp   al,0
        je    restore_exit

        cmp   ch,127
        je    restore_exit

        mov   ah,al
        mov   al,08h
```

```
        out   dx,ax

        mov   al,es:[di]  ; lower restore
        mov   es:[di],al

        jmp   short restore_exit

; here the dot is on the leftmost side so restore the left three bytes
left_3_bytes:
        cmp   ch,-128
        je    restore_exit

        sub   di,81       ; one row up, one byte left
        cmp   al,0
        je    left_up

        mov   ah,al
        mov   al,08h
        out   dx,ax

        mov   al,es:[di]  ; lower restore
        mov   es:[di],al

left_up:
        sub   di,80
        lodsb

        cmp   cl,127
        je    no_side_up

        cmp   al,0
        je    no_side_up

        mov   ah,al
        mov   al,08h
        out   dx,ax

        mov   al,es:[di]  ; lower restore
        mov   es:[di],al

no_side_up:
        add   di,160
        lodsb

        cmp   cl,-128
        je    restore_exit

        cmp   al,0
        je    restore_exit
```

```
        mov     ah,al
        mov     al,08h
        out     dx,ax

        mov     al,es:[di]  ; lower restore
        mov     es:[di],al

restore_exit:
        pop     si
        add     si,6        ; next color block
        pop     di
        ret

DO_COLOR        ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
SAVE_NEW        PROC    NEAR
; upon entry:
;       DI - center byte address
;       DL - bit offset inside the byte


        lea     bx,points
        add     bx,point_ptr
        mov     ax,ds:[bx]
        mov     bx,ax
        mov     ds:[bx],di          ; center address
        mov     ah,x
        mov     al,y
        mov     ds:[bx+2],ax                ; xy
        mov     ds:[bx+4],dl                ; bit offset

        lea     si,center_0         ; SI - the bit pattern
        xor     dh,dh
        add     si,dx
; zero out all the color information
        add     bx,5                ; start of the color information
        mov     cx,18
        xor     al,al
        push    bx
zero_loop:
        mov     ds:[bx],al
        inc     bx
        loop    zero_loop
        pop     bx

        push    dx
        m v     dx,3ceh
        m v     ax,1805h
```

```
        out     dx,ax
;       mov     al,05
;       out     dx,al
;       inc     dx
;       in      al,dx
;       or      al,08h
;       mov     ah,al
;       mov     al,05h
;       dec     dx
;       out     dx,ax
;       mov     ax,1005h            ; read mode 1... color compare
;       out     dx,ax

        mov     ax,0f07h
        out     dx,ax               ; color don't care register

        mov     ah,LIGHTGRAY              ; set the color compare register
        mov     al,02
        out     dx,ax
        pop     dx

;       jmp     exit
        call    get_color

        push    dx
        mov     dx,03ceh
        mov     ah,DARKGRAY         ; set the color compare register
        mov     al,02
        out     dx,ax
        pop     dx

        call    get_color

        push    dx
        mov     dx,03ceh
        mov     ah,BLUE                   ; set the color compare register
        mov     al,02
        out     dx,ax
        pop     dx

        call    get_color

exit:
        ret

SAVE_NEW    ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
GET_COLOR   PROC  NEAR
```

```
        push  bx           ; save the address
        push  di

        mov   al,es:[di]   ; get the pixels whixh are th  desired c l r
        and   al,ds:[si]   ; only save the bits that will change
        mov   ds:[bx],al

        sub   di,80
        cmp   y,127
        je    no_upper

        mov   al,es:[di]
        and   al,ds:[si+1]
        mov   ds:[bx+1],al

no_upper:
        add   di,160
        cmp   y,-128
        je    chk_bit_cnt

        mov   al,es:[di]
        and   al,ds:[si+1]
        mov   ds:[bx+2],al

chk_bit_cnt:
        cmp   dl,0
        je    get_left_3

        cmp   dl,6
        jne   save_exit

        cmp   x,127
        je    save_exit

        sub   di,79        ; up one, right one

        mov   al,es:[di]
        and   al,10000000b
        mov   ds:[bx+3],al

        jmp   short save_exit

get_left_3:
        cmp   x,-128
        je    save_exit

        sub   di,81        ; up one, left one

        m v   al,es:[di]
        and   al,00000011b
```

```
        mov   ds:[bx+3],al

        sub   di,80

        cmp   y,127
        je    no_left_up

        mov   al,es:[di]
        and   al,00000001b
        mov   ds:[bx+4],al

no_left_up:
        add   di,160
        cmp   y,-128
        je    save_exit

        mov   al,es:[di]
        and   al,00000001b
        mov   ds:[bx+5],al

save_exit:
        pop   di
        pop   bx
        add   bx,6

        ret

GET_COLOR    ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
ZERO_POINTS PROC  NEAR
; upon entry CX - number of points to zero
        push  es
        push  ds
        pop   es

        cld
        lea   di,point0
        xor   ax,ax
point_loop:
        push  cx
        mov   cx,23
        rep   stosb
        pop   cx
        loop  point_loop

        pop   es
        ret
```

```
ZERO_POINTS ENDP

    END
.MODEL SMALL
.286
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
;       Main transmitter
;
;       This code checks to see if the baud time is done.  If it is
;       then it modulates either marks or user data.  It uses a transmit
;       buffer which is 8K long.
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

        include     equates

        public      init_tx,tx1224,tx_flags
        public      get_tx_data,reverse_table
        public      tx_char_in,tx_char_buf_start
        public      tx_char_buf_end,tx_char_out
        public      tx_in_ptr,tx_out_ptr
        public      setup_sample_cnt,sample_count

        extrn tx_dma_on:near

        extrn rx_sample_cnt:word
        extrn rx_in:word,recv_flags:word
        extrn recv_sample_count:word
        extrn tx_sample_segment:word
        extrn rx_sample_segment:word
        extrn tx_dma_ala16:word
        extrn aic_cmd1:word,aic_cmd2:word

        extrn processed:byte


.data
        data_count  db      ?
        data_1200   db      ?
        prev_q1q0   db      ?
        tx_baud_count       dw      ?
        baud_data   dw      ?       ; data to transmit

        tx_flags    dw      ?
;
;       tx_flags.0 = 1    tx high band
;       tx_flags.1 = 1  tx 2400
;       tx_flags.2 = 1    scrambler is on
```

```
;       tx_flags.3 = 1     1200 baud data available
;       tx_flags.4 = 1     send marks
;       tx_flags.5 = 1     send S1 ( 1100 )
;       tx_flags.8 = 1   send AIC cmds
;       tx_flags.9 = 1   AIC cmds went out
;
        tx_bit_count        db     ?

        scrambler_1_16      dw     ?
        scrambler_0 db     ?

        tx_in_ptr    dw     ?
        tx_out_ptr   dw     ?

        sample_count        dw     ?      ; if number of samples is less
                                   ; than this then compute more

        sample_num   dw     ?      ; number of samples to calculate
                                   ; per baud time

        an0_ptr             dw     ?      ; an sample pointers
        an1_ptr             dw     ?
        an2_ptr             dw     ?

        bn0_ptr             dw     ?      ; bn sample pointers
        bn1_ptr             dw     ?
        bn2_ptr             dw     ?

        temp_tx_buf0        dw     16 dup(?)

        t_parse_jmp dw     ?
        tx_char_in  dw     ?
        tx_char_out dw     ?

        tx_char_buf_start label byte
        tx_char_buf db     2000 dup(?)
        tx_char_buf_end            label byte

        send_data    db     ?
.code

INIT_TX      PROC   NEAR

; don't affect which band to transmit in
        and    tx_flags,1h
        or     tx_flags,4h         ; turn on the scrambler
        mov    tx_char_in,offset tx_char_buf
        mov    tx_char_out,offset tx_char_buf

        xor    ax,ax
```

```
        mov   tx_in_ptr,ax
        mov   tx_out_ptr,ax
        mov   t_parse_jmp,ax
        mov   an0_ptr,ax
        mov   an1_ptr,ax
        mov   an2_ptr,ax
        mov   bn0_ptr,ax
        mov   bn1_ptr,ax
        mov   bn2_ptr,ax
        mov   tx_baud_count,ax

        call  setup_sample_cnt

        ret

INIT_TX     ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
SETUP_SAMPLE_CNT  PROC  NEAR

        test  tx_flags,b0
        jnz   high_band
        mov   sample_num,8
;       mov   sample_count,12
;       test  recv_flags,b0
;       jnz   counts_done
;       mov   sample_count,20          ; use larger count for tones and also
                                 ; safety at 12 and 2400 baud
        mov   sample_count,100   ; 20 ms delay for safety
        ret

high_band:
        mov   sample_num,16
;       mov   sample_count,24
;       test  recv_flags,b0
;       jnz   counts_done
;       mov   sample_count,40
        mov   sample_count,200
;counts_done:
        ret

SETUP_SAMPLE_CNT  ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
GET_TX_DATA PROC  NEAR

        mov   ax,tx_in_ptr
        sub   ax,tx_out_ptr
```

```
        jns     not_neg
        add     ax,buf_len
not_neg:
        shr     ax,1                ; word count
        cmp     ax,recv_sample_count
        stc
        jle     no_data                     ; doesn't use the Carry flag... so OK

        mov     di,rx_in
        mov     si,tx_out_ptr
        mov     cx,recv_sample_count        ; transfer just the samples needed

        mov     ax,rx_sample_segment
        mov     bx,tx_sample_segment

        push    ds
        push    es
        mov     ds,bx
        mov     es,ax
        rep     movsw
        pop     es
        pop     ds

        cmp     si,buf_len
        jne     no_tx_wrap
        xor     si,si
no_tx_wrap:

        cmp     di,buf_len
        jne     no_rx_wrap
        xor     di,di
no_rx_wrap:
        mov     tx_out_ptr,si
        mov     rx_in,di
        clc                         ; flag got data

no_data:
        ret


GET_TX_DATA ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
TX1224          PROC   NEAR

    IF board
        mov     dx,wr_clr_byte_ptr          ; init flag to low byte
         ut     dx,al
        jmp     $+2
```

```
        mov   dx,dma_5_address
        in    al,dx
        mov   cl,al
        jmp   $+2
        in    al,dx
        mov   ch,al
        jmp   $+2

; check to see if the low byte rolled over
        mov   dx,wr_clr_byte_ptr      ; init flag to low byte
        out   dx,al
        jmp   $+2

        mov   dx,dma_5_address
        in    al,dx
        cmp   al,cl
        je    no_roll
        mov   cl,al
        jmp   $+2
        in    al,dx
        mov   ch,al
        jmp   $+2

no_roll:
        mov   ax,tx_in_ptr       ; calculate the tx buffer address
        shr   ax,1          ; word address
        add   ax,tx_dma_ala16
        sub   ax,cx
        jns   pos_diff
        add   ax,( buf_len / 2 )
pos_diff:
        cmp   ax,sample_count
        jl    do_tx
        ret

    ELSE
        mov   ax,tx_in_ptr
        sub   ax,tx_out_ptr
        jns   pos_diff
        add   ax,buf_len
pos_diff:
        shr   ax,1               ; word count
        cmp   ax,sample_count
        jl    do_tx
        ret
    ENDIF

do_tx:
        add   ax,sample_num           ; this will prevent further calls t  TX
        cmp   ax,sample_c unt
```

```
        jge     no_processed
        or      pr cessed,02h
no_processed:
        and     tx_flags,NOT b9
        test    tx_flags,(b4 OR b5)
        jnz     send_marks

        test    tx_flags,b3
        jnz     get_1200_data

check_tx_data:
; parse next data here
        cmp     t_parse_jmp,0           ; any data left to parse
        je      check_tx_char
        mov     ax,t_parse_jmp
        call    ax
        jmp     short scrambler

check_tx_char:
        mov     ax,tx_char_in
        mov     si,tx_char_out
        cmp     ax,si
        je      send_marks
get_tx_char:
        lodsb                           ; get the character to transmit
        cmp     si,offset tx_char_buf_end
        jne     save_tx_ptr
        lea     si,tx_char_buf_start
save_tx_ptr:
        mov     tx_char_out,si
        shl     ax,1                    ; insert start bit
        mov     bl,al
        and     bx,0fh
        shr     ax,4
        mov     send_data,al
        mov     t_parse_jmp,offset parse_4_2_data
        jmp     short scrambler

get_1200_data:
        and     tx_flags,0fff7h
        mov     al,data_1200
        shl     al,2
        and     al,0ch
        or      al,01h
        jmp     short gray_encode

send_marks:
        mov     bx,0fh
        test    tx_flags,b5             ; send 1100 ?
        jz      scrambler
```

```
        mov   bx,0c0h

scrambler:
; data to be scrambled should be in the 1 wer 4 bits of BX
; THERE IS NO SCRAMBLER LOCKUP DETECTOR
        and   bx,0fh
        test  tx_flags,b2
        jz    no_scrambler

        mov   ax,scrambler_1_16
        xor   bx,ax
        shr   ax,3
        xor   bx,ax                 ; scrambled data is in BX.0 to BX.3

        or    ah,scrambler_0
        shr   ax,1
        and   bx,0fh
        mov   cx,bx                 ; save in CX
        shl   bx,13
        or    ax,bx                 ; shift scrambled data into the delay
        mov   scrambler_1_16,ax     ; line
        mov   bx,cx                 ; restore data
        mov   scrambler_0,0
        test  bx,b3
        jz    no_scrambler
        mov   scrambler_0,20h
no_scrambler:
        mov   al,reverse_table[bx]

check_1200:
        test  tx_flags,b1
        jnz   gray_encode

        mov   data_1200,al
        and   al,0ch
        or    al,01h
        or    tx_flags,08h

gray_encode:
        test  al,b3
        jnz   diff_encode
        xor   al,4
diff_encode:
        and   prev_q1q0,0ch
        add   al,prev_q1q0
        and   ax,0fh                      ; clear AH also
        mov   prev_q1q0,al

filter_routine:
        shl   ax,1                  ; word offset
```

```
        mov     bx,ax
        test    tx_flags,b0
        jz      low_band_filter
        jmp     high_band_filter

low_band_filter:
        mov     ax,low_band_bn[bx]
        mov     bn0_ptr,ax

        mov     ax,low_band_an[bx]
        mov     an0_ptr,ax

        mov     si,ax               ; SI = AN0 pointer
        mov     di,an1_ptr          ; DI = AN1 pointer
        mov     bx,an2_ptr          ; BX = AN2 pointer

; take care of the AIC and the receivers baud loop
        mov     cx,0fffch           ; AIC

        mov     ax,n0_low_p1[si]    ; cosine sample 0
        add     ax,n1_low_p1[di]
        add     ax,n2_low_p1[bx]
        mov     temp_tx_buf0,ax           ; cos = +1

        mov     ax,n0_low_p1[si+2]        ; cosine sample 1
        add     ax,n1_low_p1[di+2]
        add     ax,n2_low_p1[bx+2]
        neg     ax                  ; cos = -1
        mov     temp_tx_buf0+2,ax

        mov     ax,n0_low_p1[si+4]        ; cosine sample 2
        add     ax,n1_low_p1[di+4]
        add     ax,n2_low_p1[bx+4]
        neg     ax                  ; cos = -1
        mov     temp_tx_buf0+4,ax

        mov     ax,n0_low_p1[si+6]        ; cosine sample 3
        add     ax,n1_low_p1[di+6]
        add     ax,n2_low_p1[bx+6]
        mov     temp_tx_buf0+6,ax   ; cos = +1

        mov     ax,n0_low_p1[si+8]        ; cosine sample 4
        add     ax,n1_low_p1[di+8]
        add     ax,n2_low_p1[bx+8]
        mov     temp_tx_buf0+8,ax   ; cos = +1

        mov     ax,n0_low_p1[si+10]       ; cosine sample 5
        add     ax,n1_low_p1[di+10]
        add     ax,n2_low_p1[bx+10]
        neg     ax                  ; cos = -1
```

```
mov     t mp_tx_buf0+10,ax

mov     ax,n0_low_pl[si+12]      ; cosine sample 6
add     ax,nl_low_pl[di+12]
add     ax,n2_low_pl[bx+12]
neg     ax                  ; cos = -1
mov     temp_tx_buf0+12,ax

mov     ax,n0_low_pl[si+14]      ; cosine sample 7
add     ax,nl_low_pl[di+14]
add     ax,n2_low_pl[bx+14]
mov     temp_tx_buf0+14,ax       ; cos = +1

mov     si,bn0_ptr          ; SI = BN0 pointer
mov     di,bnl_ptr          ; DI = BN1 pointer
mov     bx,bn2_ptr          ; BX = BN2 pointer

mov     ax,n0_low_pl[si]    ; sine sample 0
add     ax,nl_low_pl[di]
add     ax,n2_low_pl[bx]
sub     temp_tx_buf0,ax          ; sine = -1
and     temp_tx_buf0,cx

mov     ax,n0_low_pl[si+2]       ; sine sample 1
add     ax,nl_low_pl[di+2]
add     ax,n2_low_pl[bx+2]
sub     temp_tx_buf0+2,ax ; sine = -1
and     temp_tx_buf0+2,cx

mov     ax,n0_low_pl[si+4]       ; sine sample 2
add     ax,nl_low_pl[di+4]
add     ax,n2_low_pl[bx+4]
add     temp_tx_buf0+4,ax ; sine = +1
and     temp_tx_buf0+4,cx

mov     ax,n0_low_pl[si+6]       ; sine sample 3
add     ax,nl_low_pl[di+6]
add     ax,n2_low_pl[bx+6]
add     temp_tx_buf0+6,ax ; sine = +1
and     temp_tx_buf0+6,cx

mov     ax,n0_low_pl[si+8]       ; sine sample 4
add     ax,nl_low_pl[di+8]
add     ax,n2_low_pl[bx+8]
sub     temp_tx_buf0+8,ax ; sine = -1
and     temp_tx_buf0+8,cx

mov     ax,n0_low_pl[si+10]      ; sine sample 5
add     ax,nl_low_pl[di+10]
add     ax,n2_low_pl[bx+10]
```

```
        sub     t mp_tx_buf0+10,ax       ; sine = -1
        and     temp_tx_buf0+10,cx

        mov     ax,n0_low_pl[si+12]      ; sine sample 6
        add     ax,nl_low_pl[di+12]
        add     ax,n2_low_pl[bx+12]
        add     temp_tx_buf0+12,ax       ; sine = +1
        and     temp_tx_buf0+12,cx

        mov     ax,n0_low_pl[si+14]      ; sine sample 7
        add     ax,nl_low_pl[di+14]
        add     ax,n2_low_pl[bx+14]
        add     temp_tx_buf0+14,ax       ; sine = +1
        and     temp_tx_buf0+14,cx
;
;       All the transmit samples are in the temp buffer.
;       Now shift them over to the transmit buffer.
;
        lea     si,temp_tx_buf0
        mov     es,tx_sample_segment
        mov     di,tx_in_ptr

        cmp     di,(buf_len-16)          ; near the end of the buffer?
        jl      no_wrap

        mov     cx,buf_len
        sub     cx,di
        sar     cx,1                ; number of samples to fill buffer
        mov     bx,8
        sub     bx,cx               ; number left

        rep     movsw

        xor     di,di
        mov     cx,bx

        rep     movsw

        jmp     short save_ptr

; This routine is for the switch from 7200 to 9600 recv sample rate during
; call progress
send_aic_cmds:
        cmp     di,(buf_len-22)          ; near the end of the buffer?
        jge     move_data

        or      tx_flags,b9
        and     tx_flags,NOT b8

        l dsw
```

```
        or      ax,3
        stosw
        mov     ax,aic_cmd1
        stosw
        lodsw
        or      ax,3
        stosw
        mov     ax,aic_cmd2
        stosw
        mov     cx,6
        rep     movsw
        jmp     short save_ptr

no_wrap:
        test    tx_flags,b8         ; any AIC cmds?
        jnz     send_aic_cmds
move_data:
        mov     cx,8
        rep     movsw

save_ptr:
        mov     tx_in_ptr,di

; shift the an,bn delay lines
        mov     ax,an1_ptr
        mov     an2_ptr,ax
        mov     ax,an0_ptr
        mov     an1_ptr,ax

        mov     ax,bn1_ptr
        mov     bn2_ptr,ax
        mov     ax,bn0_ptr
        mov     bn1_ptr,ax

        inc     tx_baud_count
        cmp     tx_baud_count,2
        jl      ok_leave_low

; enable DMA channel 1
        call    tx_dma_on

ok_leave_low:
        ret

;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
high_band_filter:
        mov     ax,high_band_bn[bx]
        mov     bn0_ptr,ax

        mov     ax,high_band_an[bx]
```

```
        mov     an0_ptr,ax

        mov     si,ax               ; SI = AN0 pointer
        mov     di,an1_ptr          ; DI = AN1 pointer
        mov     bx,an2_ptr          ; BX = AN2 pointer

; AIC and baud loop variables
        mov     cx,0fffch

        mov     ax,n0_high_pl[si] ; cosine sample 0
        add     ax,n1_high_pl[di]
        add     ax,n2_high_pl[bx]
        and     ax,cx
        mov     temp_tx_buf0,ax           ; cos = +1

        mov     ax,n0_high_pl[si+4]       ; cosine sample 2
        add     ax,n1_high_pl[di+4]
        add     ax,n2_high_pl[bx+4]
        neg     ax                  ; cos = -1
        and     ax,cx
        mov     temp_tx_buf0+4,ax ; skip sample 1

        mov     ax,n0_high_pl[si+8]       ; cosine sample 4
        add     ax,n1_high_pl[di+8]
        add     ax,n2_high_pl[bx+8]
        and     ax,cx
        mov     temp_tx_buf0+8,ax ; cos = +1

        mov     ax,n0_high_pl[si+12]      ; cosine sample 6
        add     ax,n1_high_pl[di+12]
        add     ax,n2_high_pl[bx+12]
        neg     ax                  ; cos = -1
        and     ax,cx
        mov     temp_tx_buf0+12,ax

        mov     ax,n0_high_pl[si+16]      ; cosine sample 8
        add     ax,n1_high_pl[di+16]
        add     ax,n2_high_pl[bx+16]
        and     ax,cx
        mov     temp_tx_buf0+16,ax        ; cos = +1

        mov     ax,n0_high_pl[si+20]      ; cosine sample 10
        add     ax,n1_high_pl[di+20]
        add     ax,n2_high_pl[bx+20]
        neg     ax                  ; cos = -1
        and     ax,cx
        mov     temp_tx_buf0+20,ax

        mov     ax,n0_high_pl[si+24]      ; cosine sample 12
        add     ax,n1_high_pl[di+24]
```

```
        add     ax,n2_high_p1[bx+24]
        and     ax,cx
        m v     temp_tx_buf0+24,ax      ; cos = +1

        mov     ax,n0_high_p1[si+28]    ; cosine sample 14
        add     ax,n1_high_p1[di+28]
        add     ax,n2_high_p1[bx+28]
        neg     ax                      ; cos = -1
        and     ax,cx
        mov     temp_tx_buf0+28,ax

        mov     si,bn0_ptr              ; SI = BN0 pointer
        mov     di,bn1_ptr              ; DI = BN1 pointer
        mov     bx,bn2_ptr              ; BX = BN2 pointer

        mov     ax,n0_high_p1[si+2]     ; sine sample 0
        add     ax,n1_high_p1[di+2]
        add     ax,n2_high_p1[bx+2]
        neg     ax
        and     ax,cx
        mov     temp_tx_buf0+2,ax

        mov     ax,n0_high_p1[si+6]     ; sine sample 1
        add     ax,n1_high_p1[di+6]
        add     ax,n2_high_p1[bx+6]
        and     ax,cx
        mov     temp_tx_buf0+6,ax

        mov     ax,n0_high_p1[si+10]    ; sine sample 2
        add     ax,n1_high_p1[di+10]
        add     ax,n2_high_p1[bx+10]
        neg     ax
        and     ax,cx
        mov     temp_tx_buf0+10,ax

        mov     ax,n0_high_p1[si+14]    ; sine sample 3
        add     ax,n1_high_p1[di+14]
        add     ax,n2_high_p1[bx+14]
        and     ax,cx
        mov     temp_tx_buf0+14,ax

        mov     ax,n0_high_p1[si+18]    ; sine sample 4
        add     ax,n1_high_p1[di+18]
        add     ax,n2_high_p1[bx+18]
        neg     ax
        and     ax,cx
        mov     temp_tx_buf0+18,ax

        mov     ax,n0_high_p1[si+22]    ; sine sample 5
        add     ax,n1_high_p1[di+22]
```

```
        add     ax,n2_high_pl[bx+22]
        and     ax,cx
        mov     temp_tx_buf0+22,ax

        mov     ax,n0_high_pl[si+26]     ; sine sample 6
        add     ax,n1_high_pl[di+26]
        add     ax,n2_high_pl[bx+26]
        neg     ax
        and     ax,cx
        mov     temp_tx_buf0+26,ax

        mov     ax,n0_high_pl[si+30]     ; sine sample 7
        add     ax,n1_high_pl[di+30]
        add     ax,n2_high_pl[bx+30]
        and     ax,cx
        mov     temp_tx_buf0+30,ax
;
;       All the transmit samples are in the temp buffer.
;       Now shift them over to the transmit buffer.
;
        mov     cx,16
        lea     si,temp_tx_buf0
        mov     es,tx_sample_segment
        mov     di,tx_in_ptr

        rep     movsw

        cmp     di,buf_len
        jne     save_in_ptr
        xor     di,di
save_in_ptr:
        mov     tx_in_ptr,di

; shift the an,bn delay lines
        mov     ax,an1_ptr
        mov     an2_ptr,ax
        mov     ax,an0_ptr
        mov     an1_ptr,ax

        mov     ax,bn1_ptr
        mov     bn2_ptr,ax
        mov     ax,bn0_ptr
        mov     bn1_ptr,ax

        inc     tx_baud_count
        cmp     tx_baud_count,2
        jl      ok_leave_high

; enable DMA channel 1
        call    tx_dma_on
```

```
ok_leave_high:
      ret


.data
reverse_table       db     00h
              db     08h
              db     04h
              db     0ch
              db     02h
              db     0ah
              db     06h
              db     0eh
              db     01h
              db     09h
              db     05h
              db     0dh
              db     03h
              db     0bh
              db     07h
              db     0fh
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
high_band_an        dw     n0_high_p1 - n0_high_p1
              dw     n0_high_p3 - n0_high_p1
              dw     n0_high_p1 - n0_high_p1
              dw     n0_high_p3 - n0_high_p1
              dw     n0_high_m1 - n0_high_p1
              dw     n0_high_m1 - n0_high_p1
              dw     n0_high_m3 - n0_high_p1
              dw     n0_high_m3 - n0_high_p1
              dw     n0_high_m1 - n0_high_p1
              dw     n0_high_m3 - n0_high_p1
              dw     n0_high_m1 - n0_high_p1
              dw     n0_high_m3 - n0_high_p1
              dw     n0_high_p1 - n0_high_p1
              dw     n0_high_p1 - n0_high_p1
              dw     n0_high_p3 - n0_high_p1
              dw     n0_high_p3 - n0_high_p1

high_band_bn        dw     n0_high_p1 - n0_high_p1
              dw     n0_high_p1 - n0_high_p1
              dw     n0_high_p3 - n0_high_p1
              dw     n0_high_p3 - n0_high_p1
              dw     n0_high_p1 - n0_high_p1
              dw     n0_high_p3 - n0_high_p1
              dw     n0_high_p1 - n0_high_p1
              dw     n0_high_p3 - n0_high_p1
              dw     n0_high_m1 - n0_high_p1
```

```
                dw      n0_high_m1 - n0_high_p1
                dw      n0_high_m3 - n0_high_p1
                dw      n0_high_m3 - n0_high_p1
                dw      n0_high_m1 - n0_high_p1
                dw      n0_high_m3 - n0_high_p1
                dw      n0_high_m1 - n0_high_p1
                dw      n0_high_m3 - n0_high_p1

low_band_an     dw      n0_low_p1 - n0_low_p1
                dw      n0_low_p3 - n0_low_p1
                dw      n0_low_p1 - n0_low_p1
                dw      n0_low_p3 - n0_low_p1
                dw      n0_low_m1 - n0_low_p1
                dw      n0_low_m1 - n0_low_p1
                dw      n0_low_m3 - n0_low_p1
                dw      n0_low_m3 - n0_low_p1
                dw      n0_low_m1 - n0_low_p1
                dw      n0_low_m3 - n0_low_p1
                dw      n0_low_m1 - n0_low_p1
                dw      n0_low_m3 - n0_low_p1
                dw      n0_low_p1 - n0_low_p1
                dw      n0_low_p1 - n0_low_p1
                dw      n0_low_p3 - n0_low_p1
                dw      n0_low_p3 - n0_low_p1

low_band_bn     dw      n0_low_p1 - n0_low_p1
                dw      n0_low_p1 - n0_low_p1
                dw      n0_low_p3 - n0_low_p1
                dw      n0_low_p3 - n0_low_p1
                dw      n0_low_p1 - n0_low_p1
                dw      n0_low_p3 - n0_low_p1
                dw      n0_low_p1 - n0_low_p1
                dw      n0_low_p3 - n0_low_p1
                dw      n0_low_m1 - n0_low_p1
                dw      n0_low_m1 - n0_low_p1
                dw      n0_low_m3 - n0_low_p1
                dw      n0_low_m3 - n0_low_p1
                dw      n0_low_m1 - n0_low_p1
                dw      n0_low_m3 - n0_low_p1
                dw      n0_low_m1 - n0_low_p1
                dw      n0_low_m3 - n0_low_p1
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
n0_high_p1      dw      -4              ; high band +1 point
                dw      -12
                dw      -28
                dw      -52
                dw      -84
                dw      -120
```

```
                dw      -152
                dw      -180
                dw      -192
                dw      -180
                dw      -140
                dw      -56
                dw      68
                dw      244
                dw      464
                dw      728

n0_high_m1      dw      4               ; high band -1 point
                dw      12
                dw      28
                dw      52
                dw      84
                dw      120
                dw      152
                dw      180
                dw      192
                dw      180
                dw      140
                dw      56
                dw      -68
                dw      -244
                dw      -464
                dw      -728

n0_high_p3      dw      3 * -4               ; high band +3 point
                dw      3 * -12
                dw      3 * -28
                dw      3 * -52
                dw      3 * -84
                dw      3 * -120
                dw      3 * -152
                dw      3 * -180
                dw      3 * -192
                dw      3 * -180
                dw      3 * -140
                dw      3 * -56
                dw      3 * 68
                dw      3 * 244
                dw      3 * 464
                dw      3 * 728

n0_high_m3      dw      3 * 4           ; high band -3 point
                dw      3 * 12
                dw      3 * 28
                dw      3 * 52
                dw      3 * 84
```

```
                dw      3 * 120
                dw      3 * 152
                dw      3 * 180
                dw      3 * 192
                dw      3 * 180
                dw      3 * 140
                dw      3 * 56
                dw      3 * -68
                dw      3 * -244
                dw      3 * -464
                dw      3 * -728
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
nl_high_p1      dw      1028            ; high band anl +1 point
                dw      1344
                dw      1668
                dw      1976
                dw      2248
                dw      2472
                dw      2628
                dw      2712
                dw      2712
                dw      2628
                dw      2472
                dw      2248
                dw      1976
                dw      1668
                dw      1344
                dw      1028

nl_high_m1      dw      -1028           ; high band anl -1 point
                dw      -1344
                dw      -1668
                dw      -1976
                dw      -2248
                dw      -2472
                dw      -2628
                dw      -2712
                dw      -2712
                dw      -2628
                dw      -2472
                dw      -2248
                dw      -1976
                dw      -1668
                dw      -1344
                dw      -1028

nl_high_p3      dw      3 * 1028                ; high band anl +3 point
                dw      3 * 1344
```

```
              dw    3 * 1668
              dw    3 * 1976
              dw    3 * 2248
              dw    3 * 2472
              dw    3 * 2628
              dw    3 * 2712
              dw    3 * 2712
              dw    3 * 2628
              dw    3 * 2472
              dw    3 * 2248
              dw    3 * 1976
              dw    3 * 1668
              dw    3 * 1344
              dw    3 * 1028

n1_high_m3    dw    3 * -1028          ; high band an1 -3 point
              dw    3 * -1344
              dw    3 * -1668
              dw    3 * -1976
              dw    3 * -2248
              dw    3 * -2472
              dw    3 * -2628
              dw    3 * -2712
              dw    3 * -2712
              dw    3 * -2628
              dw    3 * -2472
              dw    3 * -2248
              dw    3 * -1976
              dw    3 * -1668
              dw    3 * -1344
              dw    3 * -1028
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
n2_high_p1    dw    728           ; an2,bn2 +1 points
              dw    464
              dw    244
              dw    68
              dw    -56
              dw    -140
              dw    -180
              dw    -192
              dw    -180
              dw    -152
              dw    -120
              dw    -84
              dw    -52
              dw    -28
              dw    -12
              dw    -4
```

```
n2_high_m1  dw    -728          ; an2,bn2 -1 points
            dw    -464
            dw    -244
            dw    -68
            dw    56
            dw    140
            dw    180
            dw    192
            dw    180
            dw    152
            dw    120
            dw    84
            dw    52
            dw    28
            dw    12
            dw    4

n2_high_p3  dw    3 * 728            ; an2,bn2 +3 points
            dw    3 * 464
            dw    3 * 244
            dw    3 * 68
            dw    3 * -56
            dw    3 * -140
            dw    3 * -180
            dw    3 * -192
            dw    3 * -180
            dw    3 * -152
            dw    3 * -120
            dw    3 * -84
            dw    3 * -52
            dw    3 * -28
            dw    3 * -12
            dw    3 * -4

n2_high_m3  dw    3 * -728      ; an2,bn2 -3 points
            dw    3 * -464
            dw    3 * -244
            dw    3 * -68
            dw    3 * 56
            dw    3 * 140
            dw    3 * 180
            dw    3 * 192
            dw    3 * 180
            dw    3 * 152
            dw    3 * 120
            dw    3 * 84
            dw    3 * 52
            dw    3 * 28
            dw    3 * 12
            dw    3 * 4
```

```
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
n0_low_p1    dw    -8              ; an0,bn0 +1 points
             dw    -40
             dw    -100
             dw    -168
             dw    -188
             dw    -104
             dw    152
             dw    592

n0_low_m1    dw    8               ; an0,bn0 -1 points
             dw    40
             dw    100
             dw    168
             dw    188
             dw    104
             dw    -152
             dw    -592

n0_low_p3    dw    3 * -8                ; an0,bn0 +3 points
             dw    3 * -40
             dw    3 * -100
             dw    3 * -168
             dw    3 * -188
             dw    3 * -104
             dw    3 * 152
             dw    3 * 592

n0_low_m3    dw    3 * 8           ; an0,bn0 -3 points
             dw    3 * 40
             dw    3 * 100
             dw    3 * 168
             dw    3 * 188
             dw    3 * 104
             dw    3 * -152
             dw    3 * -592
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
n1_low_p1    dw    1184            ; an1,bn1 +1 points
             dw    1824
             dw    2368
             dw    2680
             dw    2680
             dw    2368
             dw    1824
             dw    1184
```

```
nl_low_ml   dw    -1184      ; anl,bnl -1 points
            dw    -1824
            dw    -2368
            dw    -2680
            dw    -2680
            dw    -2368
            dw    -1824
            dw    -1184

nl_low_p3   dw    3 * 1184   ; anl,bnl +3 points
            dw    3 * 1824
            dw    3 * 2368
            dw    3 * 2680
            dw    3 * 2680
            dw    3 * 2368
            dw    3 * 1824
            dw    3 * 1184

nl_low_m3   dw    3 * -1184  ; anl,bnl -3 points
            dw    3 * -1824
            dw    3 * -2368
            dw    3 * -2680
            dw    3 * -2680
            dw    3 * -2368
            dw    3 * -1824
            dw    3 * -1184
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
n2_low_pl   dw    592        ; an2,bn2 +1 points
            dw    152
            dw    -104
            dw    -188
            dw    -168
            dw    -100
            dw    -40
            dw    -8

n2_low_ml   dw    -592       ; an2,bn2 -1 points
            dw    -152
            dw    104
            dw    188
            dw    168
            dw    100
            dw    40
            dw    8

n2_low_p3   dw    3 * 592          ; an2,bn2 +3 p ints
            dw    3 * 152
            dw    3 * -104
```

```
              dw     3 * -188
              dw     3 * -168
              dw     3 * -100
              dw     3 * -40
              dw     3 * -8

n2_low_m3     dw     3 * -592     ; an2,bn2 -3 points
              dw     3 * -152
              dw     3 * 104
              dw     3 * 188
              dw     3 * 168
              dw     3 * 100
              dw     3 * 40
              dw     3 * 8

TX1224        ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
.code
PARSE_DATA  PROC  NEAR

parse_4_0_data:
      mov   t_parse_jmp,0
      jmp   short parse_it
parse_4_2_data:
      mov   t_parse_jmp,offset parse_2_data
      jmp   short parse_it
parse_4_4_data:
      mov   t_parse_jmp,offset parse_4_0_data
      jmp   short parse_it
parse_it:
      mov   al,send_data
      mov   bl,al
      shr   al,4
      or    al,0f0h
      mov   send_data,al
      ret

parse_2_data:
      mov   al,send_data
      or    al,0eh              ; insert stop bits
      mov   bl,al
      mov   ax,tx_char_in       ; any more chars to go out?
      mov   si,tx_char_out
      sub   ax,si
      jnz   get_next_char
      m v   t_parse_jmp,0
      ret
get_next_char:
```

```
        lodsb                       ; get the charact r to transmit
        cmp   si, ffset tx_char_buf_ nd
        jne   ok_done
        lea   si,tx_char_buf_start
  k_done:
        mov   tx_char_out,si
        and   bl,03h
        shl   ax,3                  ; insert start bit into ax.2
        or    bl,al
        shr   ax,4
        or    al,80h                      ; insert the stop bit
        mov   send_data,al
        mov   t_parse_jmp,offset parse_4_4_data
        ret

PARSE_DATA  ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
TX_COMMANDS PROC  NEAR

send_s1:
        and   tx_flags,1111111111001001b    ; 1200, no_scrambler, no marks
        or    tx_flags,0000000000100000b
        ret

send_scr_marks:
        and   tx_flags,1111111111001011b    ; no S1
        or    tx_flags,0000000000010100b    ; scrambler on , send marks
        ret

tx_data_on:
        and   tx_flags,1111111111001111b
        ret

TX_COMMANDS ENDP
        END

.model small
.286
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
;     Tone generation
;
;     This program generates all sine waves.
;     The cosine and sine are read from two tables each 256
;     words long.
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

```
        include      quates ..

        public       cosine_table,sine_table
        public       send_tones,freq,dial,freq_sum,tone_int
        public       freq2,freq_sum2,dtmf_int,dtmf

        extrn set_aic_bands:near,init_dma:near
        extrn setup_sample_cnt:near,init_timer:near
        extrn speaker_on:near,speaker_off:near
        extrn on_hook:near,off_hook:near
        extrn tx_dma_off:near,nul_routine:near
        extrn window_flip:near,tx_dma_on:near

        extrn tx_flags:word,tx_vector:word
        extrn tx_in_ptr:word,tx_sample_segment:word
        extrn sample_count:word,tx_dma_ala16:word
        extrn timer_10ms:word,recv_flags:word
        extrn display_segment:word,tx_out_ptr:word

        extrn dial_menu:byte
        extrn processed:byte


.data
                freq         dw     ?
                freq2        dw     ?
                freq_sum     dw     ?
                freq_sum2    dw     ?
.code
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
SEND_TONES   PROC  NEAR
; upon entry freq will hold the desired frequency to be sent
        push   ax
        mov    freq_sum,0
        or     tx_flags,1          ; high band
        call   setup_sample_cnt

        mov    tx_in_ptr,0


     IF board
        call   set_aic_bands
        call   init_dma
        pop    ax
        call   init_timer
        mov    tx_vector,offset tone_int
     ELSE
        pop    ax
```

```
    ENDIF

t n _loop:
    IF b ard
        test  recv_flags,b5
        jnz   end_tone
    ELSE
        call  tone_int
    ENDIF
        mov   ah,1
        int   16h
        jz    tone_loop

        mov   ah,0
        int   16h
    IF board
end_tone:
        call  tx_dma_off
        mov   tx_vector,offset nul_routine
    ENDIF
        ret

SEND_TONES  ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
TONE_INT    PROC  NEAR

    IF board
        call  tx_buf_cnt
        jc    do_tone
        ret
    ELSE
        mov   ax,tx_in_ptr
        sub   ax,tx_out_ptr
        jns   no_rollover
        add   ax,buf_len
no_rollover:
        shr   ax,1
        cmp   ax,16
        jl    do_tone
        ret
    ENDIF
do_tone:
        mov   processed,0ffh

        mov   es,tx_sample_segment
        mov   di,tx_in_ptr
        mov   cx,16          ; lo p counter
        mov   dx,0fffch
```

```
sample_l op:
        mov     bx,freq_sum
        add     bx,freq
        mov     freq_sum,bx
        mov     bl,bh
        xor     bh,bh
        sal     bx,1
        mov     ax,cosine_table[bx]
        sar     ax,1
        and     ax,dx
        stosw
        loop    sample_loop

        cmp     di,buf_len
        jne     save_ptr
        xor     di,di
save_ptr:
        mov     tx_in_ptr,di

   IF board
; enable DMA channel 1
        call    tx_dma_on
   ENDIF

        ret

TONE_INT    ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
DTMF   PROC   NEAR
; BX contains the digit to send
; AX contains the time to send the tone in 10ms counts
; This routine will abort if a key is hit and Carry will be set
        push    ax
        sal     bx,1
        mov     ax,low_table[bx]
        mov     freq,ax
        mov     ax,high_table[bx]
        mov     freq2,ax
        mov     freq_sum,0
        mov     freq_sum2,0

        or      tx_flags,1          ; high band
        call    setup_sample_cnt

        mov     tx_in_ptr,0

   IF board
        call    set_aic_bands
```

```
            call  init_dma
            pop   ax                 ; get the timer value
            call  init_timer
            mov   tx_vector,offset dtmf_int
        ENDIF

wait_loop:
            test  recv_flags,b5
            jnz   timed_out
        IFE board
            call  dtmf_int
        ENDIF
            mov   ah,1
            int   16h
            jz    wait_loop

            mov   ah,0
            int   16h
            stc
            jmp   short dtmf_done
timed_out:
            clc

dtmf_done:
        IF board
            call  tx_dma_off
            mov   tx_vector,offset nul_routine  ; turn off the tone
        ENDIF
            ret
.data
low_table    dw     1941              ; 0
             dw     1697              ; 1
             dw     1697              ; 2
             dw     1697              ; 3
             dw     1770              ; 4
             dw     1770              ; 5
             dw     1770              ; 6
             dw     1852              ; 7
             dw     1852              ; 8
             dw     1852              ; 9
             dw     1941              ; #
             dw     1941              ; *
             dw     1697              ; a
             dw     1770              ; b
             dw     1852              ; c
             dw     1941              ; d

high_table   dw     h1336             ; 0
             dw     h1209             ; 1
             dw     h1336             ; 2
```

```
                dw      h1477                   ; 3
                dw      h1209                   ; 4
                dw      h1336                   ; 5
                dw      h1477                   ; 6
                dw      h1209                   ; 7
                dw      h1336                   ; 8
                dw      h1477                   ; 9
                dw      h1477                   ; #
                dw      h1209                   ; *
                dw      h1663                   ; a
                dw      h1663                   ; b
                dw      h1663                   ; c
                dw      h1663                   ; d

DTMF   ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
.code
DTMF_INT     PROC  NEAR

   IF board
      call  tx_buf_cnt
      jc    do_dtmf
      ret
do_dtmf:
   ENDIF
      mov   processed,0ffh

      mov   es,tx_sample_segment
      mov   di,tx_in_ptr
      mov   cx,16          ; loop counter

dtmf_loop:
      mov   bx,freq_sum
      add   bx,freq
      mov   freq_sum,bx
      mov   bl,bh
      xor   bh,bh
      sal   bx,1
      mov   dx,cosine_table[bx]
      sar   dx,1           ; 1/2
      mov   bx,freq_sum2
      add   bx,freq2
      mov   freq_sum2,bx
      mov   bl,bh
      xor   bh,bh
      sal   bx,1
      m v   ax,cosine_table[bx]
      sar   ax,1           ; 1/2
```

```
        add     ax,dx
        and     ax,0fffch
        stosw
        loop    dtmf_loop

        cmp     di,buf_len
        jne     save_in_ptr
        xor     di,di
save_in_ptr:
        mov     tx_in_ptr,di

    IF board
; enable DMA channel 1
        call    tx_dma_on
    ENDIF

        ret

DTMF_INT        ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
TX_BUF_CNT  PROC  NEAR

    IF board
        mov     dx,wr_clr_byte_ptr          ; init flag to low byte
        out     dx,al
        jmp     $+2

        mov     dx,dma_5_address
        in      al,dx
        mov     cl,al
        jmp     $+2
        in      al,dx
        mov     ch,al
        jmp     $+2

; check for low byte roll over
        mov     dx,wr_clr_byte_ptr          ; init flag to low byte
        out     dx,al
        jmp     $+2

        mov     dx,dma_5_address
        in      al,dx
        cmp     al,cl
        je      no_roll
        mov     cl,al
        jmp     $+2
        in      al,dx
        m v     ch,al
```

```
        jmp     $+2

no_r 11:
        m v     ax,tx_in_ptr        ; calculate the tx buffer address
        shr     ax,1        ; word address
        add     ax,tx_dma_a1a16
        sub     ax,cx
        jns     pos_diff
        add     ax,( buf_len / 2 )
pos_diff:
        cmp     ax,sample_count
        jl      do_buf
        clc
        ret
do_buf:
        stc
        ret
    ENDIF

TX_BUF_CNT  ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
.data
cosine_table        dw      32767,32757,32728,32678,32609,32521
                dw      32412,32285,32137,31971,31785
                dw      31580,31356,31113,30852,30571
                dw      30273,29956,29621,29268,28898
                dw      28510,28105,27683,27245,26790
                dw      26319,25832,25329,24811,24279
                dw      23731,23170,22594,22005,21403
                dw      20787,20159,19519,18868,18204
                dw      17530,16846,16151,15446,14732
                dw      14010,13279,12539,11793,11039
                dw      10278,9512,8739,7962,7179
                dw      6393,5602,4808,4011,3212
                dw      2410,1608,804,0,-803
                dw      -1607,-2410,-3211,-4010,-4807
                dw      -5601,-6392,-7179,-7961,-8739
                dw      -9511,-10278,-11038,-11792,-12539
                dw      -13278,-14009,-14732,-15446,-16150
                dw      -16845,-17530,-18204,-18867,-19519
                dw      -20159,-20787,-21402,-22005,-22594
                dw      -23169,-23731,-24278,-24811,-25329
                dw      -25832,-26319,-26790,-27245,-27683
                dw      -28105,-28510,-28898,-29268,-29621
                dw      -29956,-30273,-30571,-30852,-31113
                dw      -31356,-31580,-31785,-31971,-32137
                dw      -32285,-32412,-32521,-32609,-32678
                dw      -32728,-32757,-32767,-32757,-32728
```

```
            dw      -32678,-32609,-32521,-32412,-32285
            dw      -32137,-31971,-31785,-31580,-31356
            dw      -31113,-30852,-30571,-30273,-29956
            dw      -29621,-29268,-28898,-28510,-28105
            dw      -27683,-27245,-26790,-26319,-25832
            dw      -25329,-24811,-24278,-23731,-23169
            dw      -22594,-22005,-21402,-20787,-20159
            dw      -19519,-18867,-18204,-17530,-16845
            dw      -16150,-15446,-14732,-14009,-13278
            dw      -12539,-11792,-11038,-10278,-9511
            dw      -8739,-7961,-7179,-6392,-5601
            dw      -4807,-4010,-3211,-2410,-1607
            dw      -803,0,804,1608,2410
            dw      3212,4011,4808,5602,6393
            dw      7179,7962,8739,9512,10278
            dw      11039,11793,12539,13279,14010
            dw      14732,15446,16151,16846,17530
            dw      18204,18868,19519,20159,20787
            dw      21403,22005,22594,23170,23731
            dw      24279,24811,25329,25832,26319
            dw      26790,27245,27683,28105,28510
            dw      28898,29268,29621,29956,30273
            dw      30571,30852,31113,31356,31580
            dw      31785,31971,32137,32285,32412
            dw      32521,32609,32678,32728,32757

sine_table  dw      0,804,1608,2410,3212,4011
            dw      4808,5602,6393,7179,7962
            dw      8739,9512,10278,11039,11793
            dw      12539,13279,14010,14732,15446
            dw      16151,16846,17530,18204,18868
            dw      19519,20159,20787,21403,22005
            dw      22594,23170,23731,24279,24811
            dw      25329,25832,26319,26790,27245
            dw      27683,28105,28510,28898,29268
            dw      29621,29956,30273,30571,30852
            dw      31113,31356,31580,31785,31971
            dw      32137,32285,32412,32521,32609
            dw      32678,32728,32757,32767,32757
            dw      32728,32678,32609,32521,32412
            dw      32285,32137,31971,31785,31580
            dw      31356,31113,30852,30571,30273
            dw      29956,29621,29268,28898,28510
            dw      28105,27683,27245,26790,26319
            dw      25832,25329,24811,24279,23731
            dw      23170,22594,22005,21403,20787
            dw      20159,19519,18868,18204,17530
            dw      16846,16151,15446,14732,14010
            dw      13279,12539,11793,11039,10278
            dw      9512,8739,7962,7179,6393
```

```
                dw      5602,4808,4011,3212,2410
                dw      1608,804,0,-803,-1607
                dw      -2410,-3211,-4010,-4807,-5601
                dw      -6392,-7179,-7961,-8739,-9511
                dw      -10278,-11038,-11792,-12539,-13278
                dw      -14009,-14732,-15446,-16150,-16845
                dw      -17530,-18204,-18867,-19519,-20159
                dw      -20787,-21402,-22005,-22594,-23169
                dw      -23731,-24278,-24811,-25329,-25832
                dw      -26319,-26790,-27245,-27683,-28105
                dw      -28510,-28898,-29268,-29621,-29956
                dw      -30273,-30571,-30852,-31113,-31356
                dw      -31580,-31785,-31971,-32137,-32285
                dw      -32412,-32521,-32609,-32678,-32728
                dw      -32757,-32767,-32757,-32728,-32678
                dw      -32609,-32521,-32412,-32285,-32137
                dw      -31971,-31785,-31580,-31356,-31113
                dw      -30852,-30571,-30273,-29956,-29621
                dw      -29268,-28898,-28510,-28105,-27683
                dw      -27245,-26790,-26319,-25832,-25329
                dw      -24811,-24278,-23731,-23169,-22594
                dw      -22005,-21402,-20787,-20159,-19519
                dw      -18867,-18204,-17530,-16845,-16150
                dw      -15446,-14732,-14009,-13278,-12539
                dw      -11792,-11038,-10278,-9511,-8739
                dw      -7961,-7179,-6392,-5601,-4807
                dw      -4010,-3211,-2410,-1607,-803
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
.code
DIAL    PROC    NEAR
.data
        dial_buffer db    41 dup(?)
        buffer_pointer    dw    ?
.code
        lea     si,dial_menu
        call    window_flip

; position the cursor
        mov     ah,02h
        xor     bh,bh
        mov     dh,8
        mov     dl,31
        int     10h

        mov     es,display_segment
        mov     di,((( 8 * 80 ) + 31 ) * 2 )
        xor     bx,bx
```

```
key_loop:
        mov    ah,0
        int    16h

        mov    cl,al                ; for printing
        cmp    al,cr
        je     dial_string_done

        cmp    al,bs
        jne    no_backspace

        cmp    bx,0
        je     key_loop

        mov    al,' '
        sub    di,2
        mov    es:[di],al
        dec    dl
        mov    ah,02h
        int    10h
        dec    bx
        jmp    short key_loop

no_backspace:
        cmp    al,'0'
        jb     not_digit
        cmp    al,'9'
        ja     not_digit

        sub    al,'0'
        jmp    short buffer_insert
not_digit:
        cmp    al,'#'
        jne    chk_star
        mov    al,0ah
        jmp    short buffer_insert

chk_star:
        cmp    al,'*'
        jne    chk_letter
        mov    al,0bh
        jmp    short buffer_insert

chk_letter:
        cmp    al,'A'
        jb     key_loop
        cmp    al,'D'
        ja     chk_lower
        sub    al,'A'- 0ch
        jmp    short buff r_insert
```

```
chk_l wer:
      cmp   al,'a'
      jb    key_lo p
      cmp   al,'d'
      ja    key_loop
      sub   al,'a' - 0ch

buffer_insert:
      cmp   bx,40
      je    key_loop

      mov   dial_buffer[bx],al
      inc   bx

      mov   al,cl
      stosb                   ; print the character to the screen
      inc   di

; move the cursor
      mov   ah,02h
      inc   dl
      int   10h

;     cmp   bx,40
;     jne   key_loop

;     dec   bx
;     dec   dl
;     int   10h
;     sub   di,2
      jmp   key_loop

dial_string_done:
      mov   dial_buffer[bx],0ffh

   IF board
      call  off_hook
      call  speaker_on
      mov   ax,2 * 100        ; 2 sec.
      call  init_timer

off_hook_wait:
      test  recv_flags,b5
      jz    off_hook_wait

      mov   buffer_pointer,0
dial_loop:
      mov   bx,buffer_pointer
      mov   bl,dial_buffer[bx]
      inc   buffer_pointer
```

```
        cmp   bl,0ffh
        je    dial_done
        mov   ax,7              ; 70 ms
        call  dtmf
        jc    dial_done

        mov   ax,7              ; 70 ms
        call  init_timer

inter_digit_wait:
        test  recv_flags,b5
        jz    inter_digit_wait

        jmp   short dial_loop

dial_done:
   ENDIF
; clear out the input line
        mov   es,display_segment
        mov   di,((( 8 * 80 ) + 30 ) * 2 )
        mov   al,' '
        mov   cx,41
clear_loop:
        stosb
        inc   di
        loop  clear_loop

        lea   si,dial_menu
        call  window_flip

; hide the cursor
        mov   ah,02h
        xor   bh,bh
        mov   dh,25
        mov   dl,0
        int   10h

        ret

DIAL    ENDP
        END

.model small
.286
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
;       Callp Progress
;
;       This pr gram does all the call progress finctions.
;       It uses a 7200 Hz. receive sample to detect answer t ne,
```

```
;     busy, ringing, voice, and dial tone.
;     This file also contains all the filter r utines.
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

      include      equates

      public       callp_main,touch_tone_detect
      public       aic_cmd1,aic_cmd2,init_callp,get_callp
      public       get_touch_tone

      extrn init_aic:near,init_dma:near
      extrn window_flip:near,nul_routine:near
      extrn tone_int:near,get_tx_data:near
      extrn tx1224:near,init_tx:near,setup_sample_cnt:near
      extrn init_tx_dma:near,tx_dma_off:near
      extrn rx_dma_on:near,rx_dma_off:near
      extrn dtmf_int:near

      extrn rx_sample_segment:word,rx_out:word
      extrn init_aic_tx48_rx72:word,recv_flags:word
      extrn recv_vector:word,rx_dma_ala16:word
      extrn display_segment:word,freq:word,freq_sum:word
      extrn rx_in:word,tx_in_ptr:word,tx_out_ptr:word
      extrn recv_sample_count:word,timer_10ms:word
      extrn sreg:word,tx_flags:word,tx_vector:word
      extrn freq2:word,freq_sum2:word

      extrn ttone_detect_win:byte
      extrn callp_win:byte
      extrn timer_tic:byte,timer_reload:byte

.data
;****************** DC NOTCH COEFF
      notch0_1scalar     dw    7979h
      notch0_1b1   dw    7333h

;****************** CALL PROGRESS COEFF
      callp_1scalar      dw    0db2h
      callp_1a1    dw    -578fh
      callp_1b1    dw    5db0h        ; 1/2
      callp_1b2    dw    -4dd8h

      callp_2scalar      dw    1333h
      callp_2a1    dw    4240h
      callp_2b1    dw    5b20h        ; 1/2
      callp_2b2    dw    -6e18h

      comment      !
;****************** VOICE COEFF
```

```
        voice_1scalar       dw    4873h
        voice_1a1     dw     -6470h               ; 1/2
        voice_1b1     dw     63f8h
        voice_1b2     dw     -43bah

        voice_2scalar       dw    347bh
        voice_2a1     dw     -7464h               ; 1/2
        voice_2b1     dw     4ffch          ; 1/2
        voice_2b2     dw     -72b6h

        voice_3scalar       dw    49fch
        !

;****************** ANSWER TONE COEFF
        ans_tone_1scalar dw       251h
        ans_tone_1b1        dw    -6208h
        ans_tone_1b2        dw    -7c28h

        ans_tone_2scalar dw       10a4h
        ans_tone_2b1        dw    -59b0h
        ans_tone_2b2        dw    -7c28h

;****************** TOUCH TONE DETECT COEFF
        hz697_770_1scalar dw      1c29h
        hz697_770_1a1       dw    -6fc3h                    ; 1/2
        hz697_770_1b1       dw    67bfh          ; 1/2
        hz697_770_1b2       dw    -7b23h

        hz697_770_2scalar dw      3852h
        hz697_770_2a1       dw    -5bceh                    ; 1/2
        hz697_770_2b1       dw    6184h          ; 1/2
        hz697_770_2b2       dw    -7b23h

        hz1209_1336_1scalar dw    199ah
        hz1209_1336_1a1     dw    -4db3h                    ; 1/2
        hz1209_1336_1b1     dw    7df0h
        hz1209_1336_1b2     dw    -799ah

        hz1209_1336_2scalar dw    4148h
        hz1209_1336_2a1     dw    -43e0h
        hz1209_1336_2b1     dw    5f36h
        hz1209_1336_2b2     dw    -799ah

        sample              dw    ?
; call progress delay line variables
        notch0_10     dw    ?
        notch0_11     dw    ?
        notch0_21     dw    ?

        comment       !
```

```
        voice_11    dw    ?
        voice_12    dw    ?
        voice_21    dw    ?
        voice_22    dw    ?
        voice_31    dw    ?
        voice_32    dw    ?
        voice_41    dw    ?
        voice_42    dw    ?
        voice_51    dw    ?
        !

        callp_11    dw    ?
        callp_12    dw    ?
        callp_21    dw    ?
        callp_22    dw    ?
        callp_31    dw    ?
        callp_32    dw    ?
        callp_41    dw    ?
        callp_42    dw    ?

        ans_tone_11 dw    ?
        ans_tone_12 dw    ?
        ans_tone_21 dw    ?
        ans_tone_22 dw    ?
        ans_tone_31 dw    ?
        ans_tone_32 dw    ?
        ans_tone_41 dw    ?
        ans_tone_42 dw    ?

        no_filter_sum_high      dw    ?
        no_filter_sum_low dw    ?
;       voice_sum_high          dw    ?
;       voice_sum_low           dw    ?
        callp_sum_high          dw    ?
        callp_sum_low           dw    ?
        ans_tone_sum_high dw    ?
        ans_tone_sum_low  dw    ?

        old_no_filt_high  dw    ?
        old_no_filt_low         dw    ?
;       old_voice_high          dw    ?
;       old_voice_low           dw    ?
        old_callp_high          dw    ?
        old_callp_low           dw    ?
        old_atone_high          dw    ?
        old_atone_low           dw    ?

        sample_count      dw    ?
        scount_reload     dw    ?
```

```
; Touch T ne detect variables
        hz697_770_11        dw      ?
        hz697_770_12        dw      ?
        hz697_770_21        dw      ?
        hz697_770_22        dw      ?
        hz697_770_31        dw      ?
        hz697_770_32        dw      ?
        hz697_770_41        dw      ?
        hz697_770_42        dw      ?

        hz1209_1336_11      dw      ?
        hz1209_1336_12      dw      ?
        hz1209_1336_21      dw      ?
        hz1209_1336_22      dw      ?
        hz1209_1336_31      dw      ?
        hz1209_1336_32      dw      ?
        hz1209_1336_41      dw      ?
        hz1209_1336_42      dw      ?

        fil697_sum_high             dw      ?
        fil697_sum_low              dw      ?
        old_fil697_high             dw      ?
        old_fil697_low              dw      ?

        fil1209_sum_high    dw      ?
        fil1209_sum_low             dw      ?
        old_fil1209_high    dw      ?
        old_fil1209_low             dw      ?

ascii_converter             db      '0','1','2','3','4','5','6','7','8','9'
                    db      'A','B','C','D','E','F'

        aic_cmd1    dw      ?
        aic_cmd2    dw      ?

.code
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
CALLP_FILTERS       PROC    NEAR

        call    chk_sample_count
        jnc     do_callp
        ret

end_atone_routine:
; answer tone mean square
        mov     ax,bx           ; output ^ 2
        imul    bx
        mov     bx,dx           ; DX:AX already divided by 2
```

```
        and     bx,0fh          ; shift right by 4 to get one 32nd
        rol     bx,4
        sar     dx,4
        shr     ax,4
        or      ah,bl
        add     ans_tone_sum_low,ax
        adc     ans_tone_sum_high,dx
        jmp     count_it

do_callp:
        mov     es,rx_sample_segment
        mov     si,rx_out       ; filter sample pointer
filter_loop:
        mov     ax,es:[si]      ; input sample
        add     si,2

        mov     sample,ax
        test    recv_flags,b8
        jnz     answer_tone_filter

; Remove any DC from the sample ---- NOTCH 0
        mov     bx,notch0_11
        neg     bx              ; -1
        imul    notch0_1scalar
        sal     dx,1
        mov     notch0_11,dx
        add     bx,dx
        mov     ax,notch0_21
        imul    notch0_1b1
        sal     dx,1
        add     bx,dx
        mov     notch0_21,bx
        mov     sample,bx

; No filter averaging
        mov     ax,bx           ; output ^ 2
        imul    bx
        sal     ax,1            ; adjust for the multiply
        rcl     dx,1
        mov     al,ah           ; divide by 256
        mov     ah,dl
        mov     dl,dh
        xor     dh,dh           ; result is positive
        add     no_filter_sum_low,ax
        adc     no_filter_sum_high,dx

; Answer tone filter
answer_tone_filt r:
        mov     bx,ans_tone_12
        mov     ax,ans_tone_11
```

```
        mov   ans_tone_12,ax
        sar   ax,2
        neg   ax
        add   ax,ans_tone_11            ; .75 * ans_tone_11
        sub   bx,ax
        mov   ax,sample
        imul  ans_tone_1scalar
        sal   dx,1
        mov   ans_tone_11,dx
        add   bx,dx
        mov   ax,ans_tone_22
        imul  ans_tone_1b2
        sal   dx,1
        add   bx,dx
        mov   ax,ans_tone_21
        mov   ans_tone_22,ax
        imul  ans_tone_1b1
        sal   dx,1
        add   bx,dx
        mov   ans_tone_21,bx            ; output of the first filter stage

        mov   ax,bx
        imul  ans_tone_2scalar
        sal   dx,1
        mov   bx,ans_tone_32
        mov   ax,ans_tone_31
        mov   ans_tone_32,ax
        sar   ax,2
        add   ax,ans_tone_31
        add   bx,ax
        mov   ans_tone_31,dx
        add   bx,dx
        mov   ax,ans_tone_42
        imul  ans_tone_2b2
        sal   dx,1
        add   bx,dx
        mov   ax,ans_tone_41
        mov   ans_tone_42,ax
        imul  ans_tone_2b1
        sal   dx,1
        add   bx,dx          ; second stage output  BX - output
        mov   ans_tone_41,bx

        test  recv_flags,b8
        jz    do_mean_square
        jmp   end_atone_routine
do_mean_square:
; answer tone mean square
        mov   ax,bx       ; output ^ 2
        imul  bx
```

```
        sal     ax,1            ; adjust for th  multiply
        rcl     dx,1
        mov     al,ah           ; divide by 256
        mov     ah,dl
        mov     dl,dh
        xor     dh,dh           ; result is positive
        add     ans_tone_sum_low,ax
        adc     ans_tone_sum_high,dx

        comment      !
; Voice filter
        mov     bx,voice_12
        mov     ax,voice_11
        mov     voice_12,ax
        imul    voice_1a1
        sal     dx,2                    ; * 2
        add     bx,dx
        mov     ax,sample
        imul    voice_1scalar
        sal     dx,1
        mov     voice_11,dx
        add     bx,dx

        mov     ax,voice_22
        imul    voice_1b2
        sal     dx,1
        add     bx,dx
        mov     ax,voice_21
        mov     voice_22,ax
        imul    voice_1b1
        sal     dx,1
        add     bx,dx                   ; 1st stage output
        mov     voice_21,bx

        mov     ax,bx
        imul    voice_2scalar
        sal     dx,1
        mov     bx,voice_32
        mov     ax,voice_31
        mov     voice_32,ax
        mov     voice_31,dx
        add     bx,dx
        imul    voice_2a1
        sal     dx,2                    ; * 2
        add     bx,dx

        mov     ax,voice_42
        imul    voice_2b2
        sal     dx,1
        add     bx,dx
```

```
        mov   ax,voice_41
        mov   voice_42,ax
        imul  voice_2b1
        sal   dx,2              ; * 2
        add   bx,dx             ; 2nd stage output
        mov   voice_41,bx

        mov   ax,bx
        imul  voice_3scalar
        sal   dx,2              ; * 2
        mov   ax,voice_51
        mov   voice_51,dx
        sub   dx,ax             ; dx = output

; voice mean square
        mov   ax,dx        ; output ^ 2
        imul  dx
        sal   ax,1         ; adjust for the multiply
        rcl   dx,1
        mov   al,ah        ; divide by 256
        mov   ah,dl
        mov   dl,dh
        xor   dh,dh        ; result is positive
        add   voice_sum_low,ax
        adc   voice_sum_high,dx
        !

; Call Progress filter
        mov   bx,callp_12
        mov   ax,callp_11
        mov   callp_12,ax
        imul  callp_1a1
        sal   dx,1
        add   bx,dx
        mov   ax,sample
        imul  callp_1scalar
        sal   dx,1
        mov   callp_11,dx
        add   bx,dx

        mov   ax,callp_22
        imul  callp_1b2
        sal   dx,1
        add   bx,dx
        mov   ax,callp_21
        mov   callp_22,ax
        imul  callp_1b1
        sal   dx,2
        add   bx,dx
        mov   callp_21,bx       ; 1st stage  utput
```

```
      mov   ax,bx
      imul  callp_2scalar
      sal   dx,1
      mov   bx,callp_32
      mov   ax,callp_31
      mov   callp_32,ax
      mov   callp_31,dx
      add   bx,dx
      imul  callp_2a1
      sal   dx,1
      add   bx,dx

      mov   ax,callp_42
      imul  callp_2b2
      sal   dx,1
      add   bx,dx
      mov   ax,callp_41
      mov   callp_42,ax
      imul  callp_2b1
      sal   dx,2
      add   bx,dx
      mov   callp_41,bx        ; BX - output

; call progress mean square
      mov   ax,bx        ; output ^ 2
      imul  bx
      sal   ax,1         ; adjust for the multiply
      rcl   dx,1
      mov   al,ah        ; divide by 256
      mov   ah,dl
      mov   dl,dh
      xor   dh,dh        ; result is positive
      add   callp_sum_low,ax
      adc   callp_sum_high,dx


count_it:
      dec   sample_count
      jnz   check_samples
      or    recv_flags,b7

      mov   ax,scount_reload
      mov   sample_count,ax

      xor   dx,dx

      mov   ax,no_filter_sum_low
      m v   bx,no_filter_sum_high
      mov   old_no_filt_low,ax
      mov   old_n _filt_high,bx
```

```
        mov   no_filter_sum_low,dx
        mov   no_filter_sum_high,dx

        comment     !
        mov   ax,voice_sum_low
        mov   bx,voice_sum_high
        mov   old_voice_low,ax
        mov   old_voice_high,bx
        mov   voice_sum_low,dx
        mov   voice_sum_high,dx
        !

        mov   ax,callp_sum_low
        mov   bx,callp_sum_high
        mov   old_callp_low,ax
        mov   old_callp_high,bx
        mov   callp_sum_low,dx
        mov   callp_sum_high,dx

        mov   ax,ans_tone_sum_low
        mov   bx,ans_tone_sum_high
        mov   old_atone_low,ax
        mov   old_atone_high,bx
        mov   ans_tone_sum_low,dx
        mov   ans_tone_sum_high,dx

check_samples:
        cmp   si,rx_samples_length
        jne   no_wrap
        xor   si,si
no_wrap:
        dec   cx
        jcxz  no_samples
        jmp   filter_loop
no_samples:
        mov   rx_out,si
        ret

CALLP_FILTERS     ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
DTMF_FILTERS      PROC  NEAR

        call  chk_sample_count
        jnc   do_ttone
        ret

do_ttone:
        m v   es,rx_sample_segment
```

```
        mov    si,rx_out    ; filter sample pointer
tton _filter_loop:
        mov    ax,es:[si]   ; input sample
        add    si,2

        mov    sample,ax

; Remove any DC from the sample ---- NOTCH 0
        mov    bx,notch0_11
        neg    bx                   ; -1
        imul   notch0_lscalar
        sal    dx,1
        mov    notch0_11,dx
        add    bx,dx
        mov    ax,notch0_21
        imul   notch0_lb1
        sal    dx,1
        add    bx,dx
        mov    notch0_21,bx
        mov    sample,bx

; No filter averaging
        mov    ax,bx        ; output ^ 2
        imul   bx
        sal    ax,1         ; adjust for the multiply
        rcl    dx,1
        mov    al,ah        ; divide by 256
        mov    ah,dl
        mov    dl,dh
        xor    dh,dh        ; result is positive
        add    no_filter_sum_low,ax
        adc    no_filter_sum_high,dx

; 697 - 770 Hz filter
filter_697:
        mov    bx,hz697_770_12
        mov    ax,hz697_770_11
        mov    hz697_770_12,ax
        imul   hz697_770_la1
        sal    dx,2                 ; * 2
        add    bx,dx
        mov    ax,sample
        imul   hz697_770_lscalar
        sal    dx,1
        mov    hz697_770_11,dx
        add    bx,dx
        mov    ax,hz697_770_22
        imul   hz697_770_lb2
        sal    dx,1
        add    bx,dx
```

```
        mov     ax,hz697_770_21
        mov     hz697_770_22,ax
        imul    hz697_770_1b1
        sal     dx,2                ; * 2
        add     bx,dx
        mov     hz697_770_21,bx         ; output of the first filter stage


        mov     ax,bx
        imul    hz697_770_2scalar
        sal     dx,1
        mov     bx,hz697_770_32
        mov     ax,hz697_770_31         ; shift the delay line
        mov     hz697_770_32,ax
        add     bx,dx
        mov     hz697_770_31,dx         ; store the input * scalar
        imul    hz697_770_2a1
        sal     dx,2                ; * 2
        add     bx,dx
        mov     ax,hz697_770_42
        imul    hz697_770_2b2
        sal     dx,1
        add     bx,dx
        mov     ax,hz697_770_41
        mov     hz697_770_42,ax
        imul    hz697_770_2b1
        sal     dx,2                ; * 2
        add     bx,dx
        mov     hz697_770_41,bx         ; second stage output  BX = output

; fil 697 - 770 mean square
        mov     ax,bx           ; output ^ 2
        imul    bx
        sal     ax,1            ; adjust for the multiply
        rcl     dx,1
        mov     al,ah           ; divide by 256
        mov     ah,dl
        mov     dl,dh
        xor     dh,dh           ; result is positive
        add     fil697_sum_low,ax
        adc     fil697_sum_high,dx

; 1209 - 1336 Hz filter
filter_1209:
        mov     bx,hz1209_1336_12
        mov     ax,hz1209_1336_11
        mov     hz1209_1336_12,ax
        imul    hz1209_1336_1a1
        sal     dx,2            ; * 2
        add     bx,dx
```

```
        mov     ax,sample
        imul    hz1209_1336_1scalar
        sal     dx,1
        mov     hz1209_1336_11,dx
        add     bx,dx

        mov     ax,hz1209_1336_22
        imul    hz1209_1336_1b2
        sal     dx,1
        add     bx,dx
        mov     ax,hz1209_1336_21
        mov     hz1209_1336_22,ax
        imul    hz1209_1336_1b1
        sal     dx,1
        add     bx,dx
        mov     hz1209_1336_21,bx       ; output of the first filter stage

        mov     ax,bx
        imul    hz1209_1336_2scalar
        sal     dx,1
        mov     bx,hz1209_1336_32
        mov     ax,hz1209_1336_31       ; shift the delay line
        mov     hz1209_1336_32,ax
        mov     hz1209_1336_31,dx       ; store the input * scalar
        add     bx,dx
        imul    hz1209_1336_2a1
        sal     dx,1
        add     bx,dx
        mov     ax,hz1209_1336_42
        imul    hz1209_1336_2b2
        sal     dx,1
        add     bx,dx
        mov     ax,hz1209_1336_41
        mov     hz1209_1336_42,ax
        imul    hz1209_1336_2b1
        sal     dx,1
        add     bx,dx                ; second stage output  BX = output
        mov     hz1209_1336_41,bx

; fil 1209 - 1336 mean square
        mov     ax,bx           ; output ^ 2
        imul    bx
        sal     ax,1            ; adjust for the multiply
        rcl     dx,1
        mov     al,ah           ; divide by 256
        mov     ah,dl
        mov     dl,dh
        xor     dh,dh           ; result is p sitive
        add     fil1209_sum_low,ax
        adc     fil1209_sum_high,dx
```

```
c unt_sample:
      dec    sample_count
      jnz    check_sample_buf
      or     recv_flags,b7

      mov    ax,scount_reload
      mov    sample_count,ax

      xor    dx,dx

      mov    ax,no_filter_sum_low
      mov    bx,no_filter_sum_high
      mov    old_no_filt_low,ax
      mov    old_no_filt_high,bx
      mov    no_filter_sum_low,dx
      mov    no_filter_sum_high,dx

      mov    ax,fil697_sum_low
      mov    bx,fil697_sum_high
      mov    old_fil697_low,ax
      mov    old_fil697_high,bx
      mov    fil697_sum_low,dx
      mov    fil697_sum_high,dx

      mov    ax,fil1209_sum_low
      mov    bx,fil1209_sum_high
      mov    old_fil1209_low,ax
      mov    old_fil1209_high,bx
      mov    fil1209_sum_low,dx
      mov    fil1209_sum_high,dx

check_sample_buf:
      cmp    si,rx_samples_length
      jne    no_end
      xor    si,si
no_end:
      dec    cx
      jcxz   no_more_samples
      jmp    ttone_filter_loop
no_more_samples:
      mov    rx_out,si
      ret

DTMF_FILTERS      ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
CALLP_INIT  PROC  NEAR

   IF board
```

```
        lea     si,init_aic_tx48_rx72    ; tx 4800 rx 7200
        call    init_aic
        call    init_dma
     ELSE
        xor     ax,ax
        mov     tx_in_ptr,ax
        mov     tx_out_ptr,ax
        mov     rx_in,ax
     ENDIF

        mov     rx_out,0
        mov     sample_count,256
        mov     scount_reload,256
        ret

CALLP_INIT  ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
CALLP_MAIN  PROC  NEAR
.data
        atone_cnt    dw     ?
.code
        call    callp_init

        lea     si,callp_win
        call    window_flip

     IF board
        mov     ax,sreg+9
        mov     atone_cnt,ax

        mov     ax,sreg+7
        mov     bx,50
        mul     bx
        cli
        mov     timer_10ms,ax
        mov     timer_tic,9
        mov     timer_reload,9
        and     recv_flags,NOT( b5 OR b7 OR b8 )
        mov     recv_vector,offset callp_filters
        sti

; enable DMA channel 2  RECV DMA
        call    rx_dma_on
     ELSE
        mov     recv_sample_count,16
        mov     freq,20252          ; 2225 Hz at a 7200 Hz sample rate
;       m v     freq,3231           ; 1210
        mov     freq_sum,0
```

```
   ENDIF

callp_loop:
   IFE      board
      mov   cx,20000
here:
      loop  here
      call  tone_int
      call  get_tx_data
      call  callp_filters
   ELSE
      test  recv_flags,b5
      jnz   callp_exit
   ENDIF
      test  recv_flags,b7
      jz    callp_loop

      and   recv_flags,NOT b7

   IF board
; check the thresholds
      cmp   old_atone_high,0
      jne   got_atone
      cmp   old_atone_low,4000h
      jb    no_atone
got_atone:
; is ans_tone > no_filt/4 ?
      mov   ax,old_no_filt_high
      mov   bx,old_no_filt_low
      sar   ax,1
      rcr   bx,1
      sar   ax,1
      rcr   bx,1
      cmp   old_atone_high,ax
      jl    no_atone
      jg    got_it
      cmp   old_atone_low,bx        ; high parts are equal
      jb    no_atone
got_it:
      dec   atone_cnt
      jz    get_end_atone
      jmp   short display_levels
no_atone:
      mov   ax,sreg+9
      mov   atone_cnt,ax
display_levels:
   ENDIF
      call  print_callp

      mov   ah,1
```

```
        int     16h
        jz      callp_loop

        mov     ah,0
        int     16h

callp_exit:
        lea     si,callp_win
        call    window_flip

call_exit:
   IF board
; disable DMA channel 2 RECV DMA
        call    rx_dma_off
        mov     recv_vector,offset nul_routine
   ENDIF

        stc
        ret

   IF board
get_end_atone:
; look for 4.44 ms samples
        cli
        mov     sample_count,32
        mov     scount_reload,32
        mov     ans_tone_sum_low,0
        mov     ans_tone_sum_high,0
        or      recv_flags,b8          ; end of answer tone
        sti

        mov     atone_cnt,17           ; this is the success flag
        mov     ax,old_atone_low
        mov     bx,old_atone_high
        sar     bx,1
        rcr     ax,1
        sar     bx,1
        rcr     ax,1             ; BX,AX holds end answer tone threshold

        push    ax
        push    bx

        lea     si,callp_win
        call    window_flip

        call    init_tx_dma
        and     tx_flags,0fffeh        ; tx low
        call    init_tx

        mov     tx_vector,offset tx1224 ; start the transmitter
```

```
        pop   bx
        pop   ax

end_atone_loop:
        test  recv_flags,b5
        jnz   callp_exit
        test  recv_flags,b7
        jz    end_atone_loop

        and   recv_flags,NOT b7
        mov   dx,old_atone_high
        mov   cx,old_atone_low
        sub   cx,ax
        sbb   dx,bx
        js    got_end

        push  ax
        mov   ah,1
        int   16h
        pop   ax
        jz    end_atone_loop

        mov   ah,0
        int   16h

        mov   tx_vector,offset nul_routine
        call  tx_dma_off

        jmp   call_exit

got_end:
; disable DMA channel 2 RECV DMA
        call  rx_dma_off
        mov   recv_vector,offset nul_routine

        mov   aic_cmd1,383ch
        mov   aic_cmd2,3c72h
        or    tx_flags,b8

wait1:
        test  tx_flags,b8
        jnz   wait1

wait2:
        test  tx_flags,b9
        jnz   wait2

        clc
        ret
```

```
   ENDIF
CALLP_MAIN  ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
PRINT_WORD  PROC  NEAR
; upon entry DI - screen offset, CL - attribute, and DX - word to print
      mov   bl,dh
      ror   bl,4
      and   bl,0fh
      xor   bh,bh
      mov   al,byte ptr ascii_converter[bx]
      stosw
      mov   bl,dh
      and   bl,0fh
      mov   al,byte ptr ascii_converter[bx]
      stosw
      mov   bl,dl
      ror   bl,4
      and   bl,0fh
      mov   al,byte ptr ascii_converter[bx]
      stosw
      mov   bl,dl
      and   bl,0fh
      mov   al,byte ptr ascii_converter[bx]
      stosw
      ret

PRINT_WORD  ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
PRINT_CALLP PROC  NEAR

; print the result in the callp progress window
      mov   di,((( 9 * 80 ) + 47 ) * 2 )  ; screen offset
      xor   bx,bx
      mov   es,display_segment
      mov   ah,31h                        ; attribute
      mov   dx,old_no_filt_high
      call  print_word
      mov   dx,old_no_filt_low
      call  print_word

      mov   di,((( 10 * 80 ) + 47 ) * 2 )
      mov   dx,old_callp_high
      call  print_word
      m v   dx,old_callp_l w
      call  print_word
```

```
        comment     !
        mov   di,((( 9 * 80 ) + 44 ) * 2 )
        mov   dx,old_voice_high
        call  print_word
        mov   dx,old_voice_low
        call  print_word
        !

        mov   di,((( 11 * 80 ) + 47 ) * 2 )
        mov   dx,old_atone_high
        call  print_word
        mov   dx,old_atone_low
        call  print_word
        ret

PRINT_CALLP ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
TOUCH_TONE_DETECT PROC  NEAR

        lea   si,ttone_detect_win
        call  window_flip

        call  setup_dtmf_detect

; main loop
ttone_detect_loop:
   IFE board
        mov   cx,40000
here2:
        loop  here2
        call  dtmf_int
        call  get_tx_data
        call  dtmf_filters
   ENDIF
        test  recv_flags,b7
        jz    ttone_detect_loop

        and   recv_flags,NOT b7

        call  print_dtmf

        mov   ah,1
        int   16h
        jz    ttone_detect_loop

        mov   ah,0
        int   16h
```

```
        lea   si,ttone_detect_win
        call  window_flip

     IF board
; disable DMA channel 2 RECV DMA
        call  rx_dma_off
        mov   recv_vector,offset nul_routine
     ENDIF
        stc
        ret

TOUCH_TONE_DETECT ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
PRINT_DTMF  PROC  NEAR

; print the result in the callp progress window
        mov   di,((( 10 * 80 ) + 47 ) * 2 ) ; screen offset
        xor   bx,bx
        mov   es,display_segment
        mov   ah,31h                        ; attribute
        mov   dx,old_no_filt_high
        call  print_word
        mov   dx,old_no_filt_low
        call  print_word

        mov   di,((( 11 * 80 ) + 47 ) * 2 ) ; screen offset
        xor   bx,bx
        mov   es,display_segment
        mov   ah,31h                        ; attribute
        mov   dx,old_fil697_high
        call  print_word
        mov   dx,old_fil697_low
        call  print_word

        mov   di,((( 12 * 80 ) + 47 ) * 2 ) ; screen offset
        xor   bx,bx
        mov   es,display_segment
        mov   ah,31h                        ; attribute
        mov   dx,old_fil1209_high
        call  print_word
        mov   dx,old_fil1209_low
        call  print_word

        ret

PRINT_DTMF  ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
```

```
;
CHK_SAMPLE_COUNT  PROC  NEAR

   IF board
      mov   dx,wr_clr_byte_ptr       ; init flag to 1 w byte
      out   dx,al
      jmp   $+2

; how many words are there in the receive buffer?
      mov   dx,dma_6_address  ; get RX in
      in    al,dx
      mov   cl,al
      jmp   $+2
      in    al,dx
      mov   ch,al
      jmp   $+2

      mov   dx,wr_clr_byte_ptr       ; init flag to low byte
      out   dx,al
      jmp   $+2

      mov   dx,dma_6_address
      in    al,dx
      cmp   cl,al
      je    read_ok
      mov   cl,al
      in    al,dx
      mov   ch,al
read_ok:
      mov   ax,rx_out
      shr   ax,1
      add   ax,rx_dma_a1a16
      sub   cx,ax
      jns   pos_diff
      add   cx,(rx_samples_length/2)
pos_diff:
      jnz   do_funct
      stc
      ret

   ELSE
      mov   cx,rx_in
      sub   cx,rx_out
      jns   no_rollover
      add   cx,rx_samples_length
no_rollover:
      shr   cx,1         ; word count
      jnz   do_funct
      stc
      ret
```

```
   ENDIF
d _funct:
      clc
      ret

CHK_SAMPLE_COUNT   ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
INIT_CALLP   PROC   NEAR

      call   callp_init

      cli
      and    recv_flags,NOT( b5 OR b7 OR b8 )
      mov    recv_vector,offset callp_filters
      sti

; enable DMA channel 2  RECV DMA
      call   rx_dma_on

      ret
INIT_CALLP   ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
GET_CALLP    PROC   NEAR

answer_loop:
      test   recv_flags,b7
      jz     answer_loop

      and    recv_flags,NOT b7

      call   print_callp

      xor    al,al
      mov    bx,old_callp_high
      cmp    bx,0h
      je     no_callp
      or     al,1
no_callp:
      ret

GET_CALLP    ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
SETUP_DTMF_DETECT PROC   NEAR
      call   callp_init
```

```
        mov     r cv_sampl _count,16
     IFE board
        mov     freq,1697_72s
;       mov     freq,0
        mov     freq2,h1336_72s
;       mov     freq2,0
;       mov     freq,tone_2225_72s
;       mov     freq2,tone_2225_72s-200
        mov     freq_sum,0
        mov     freq_sum2,0
     ELSE
        cli
        and     recv_flags,NOT( b5 OR b7 OR b8 )
        mov     recv_vector,offset dtmf_filters
        sti

; enable DMA channel 2  RECV DMA
        call    rx_dma_on
      ENDIF
        ret
SETUP_DTMF_DETECT ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
GET_TOUCH_TONE     PROC   NEAR

        call    setup_dtmf_detect

; main loop
detect_loop:
        mov     ah,1
        int     16h
        jnz     abort_out
        test    recv_flags,b7
        jz      detect_loop

        and     recv_flags,NOT b7

; check the thresholds
        cmp     old_fil697_high,100h
        jl      detect_loop

got_ttone:
; is ans_tone > no_filt/4 ?
        mov     ax,old_no_filt_high
        mov     bx,old_no_filt_low
        sar     ax,1
        rcr     bx,1
        sar     ax,1
        rcr     bx,1
```

```
        cmp     ld_fil697_high,ax
        jl      detect_l op
g t_697:
        cmp     old_fil1209_high,ax
        jl      detect_lo p

end_loop:
        mov     ah,1
        int     16h
        jnz     abort_out
        test    recv_flags,b7
        jz      end_loop

        and     recv_flags,NOT b7

; check the thresholds
        cmp     old_fil697_high,100h
        jg      end_loop
        jmp     short ok_end

abort_out:
        mov     ah,0
        int     16h
ok_end:
   IF board
; disable DMA channel 2 RECV DMA
        call    rx_dma_off
        mov     recv_vector,offset nul_routine
   ENDIF
        stc
        ret

GET_TOUCH_TONE      ENDP
        END

.286
.model      small
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
;       WIN is the pop-up window manager
;
;       WIN uses window_init to decompress the windows into RAM.
;       Window_flip and window_up actually print the desired window to the
;       screen.
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

        include equates

        public      init_screen
```

```
	public	window_flip
	public	main_menu,start_message,end_message
	public	dial_menu, nline_msg,window_up
	public	outgoing_msg,recording_msg,callp_win
	public	ttone_detect_win

	extrn display_segment:word

	extrn attribute:byte

window	macro corner_x,corner_y,x,y

	db	corner_x,corner_y,x,y
	dw	x*y dup	(?)

	endm

; definitions for the compress window macros

.data
	corner		dw	?

	include		sft_wins.inc

.code
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
INIT_SCREEN PROC  NEAR

	mov	al,'▒'
	mov	ah,attribute
	call	fill_screen

	lea	si,top_menu
	call	window_up

	lea	si,bottom_menu
	call	window_up

	ret

INIT_SCREEN ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
FILL_SCREEN PROC  NEAR

	mov	cx,2000
	mov	es,display_segment
```

```
        xor    di,di
        rep    stosw
        ret

FILL_SCREEN ENDP
;
;-----------------------
;
WINDOW_FLIP PROC  NEAR

        mov    bx,si

; calculate the offset into the display
        xor    ax,ax
        mov    al,[bx]                  ;( row + column) * 2
        mov    cl,80
        imul   cl
        mov    cl,[bx+1]
        xor    ch,ch
        add    ax,cx
        shl    ax,1
        mov    di,ax
        mov    corner,ax
        mov    ax,display_segment
        mov    es,ax

        xor    cx,cx
        mov    cl,[bx][2]               ; window rows
        add    si,4                     ; point to the window

new_row:
        push   cx
        mov    cl,[bx][3]               ; columns
mov_loop:
        lodsw
        xchg   ax,es:[di]
        mov    ds:[si][-2],ax
        add    di,2
        loop   mov_loop

        mov    ax,corner
        add    ax,160                         ; add a line
        mov    di,ax
        mov    corner,ax

        pop    cx
        loop   new_row

        ret
```

```
WINDOW_FLIP ENDP
;
;-----------------------
;
WINDOW_UP    PROC   NEAR

      mov    bx,si

; calculate the offset into the display
      xor    ax,ax
      mov    al,[bx]                  ;( row + column) * 2
      mov    cl,80
      imul   cl
      mov    cl,[bx+1]
      xor    ch,ch
      add    ax,cx
      shl    ax,1
      mov    di,ax
      mov    corner,ax
      mov    ax,display_segment
      mov    es,ax

      xor    cx,cx
      mov    cl,[bx][2]               ; window rows
      add    si,4                     ; point to the window

new_row2:
      push   cx
      mov    cl,[bx][3]               ; columns
;mov_loop:
;     lodsw
;     xchg   ax,es:[di]
;     mov    ds:[si][-2],ax
;     add    di,2
;     loop   mov_loop
      rep    movsw

      mov    ax,corner
      add    ax,160                         ; add a line
      mov    di,ax
      mov    corner,ax

      pop    cx
      loop   new_row2

      ret

WINDOW_UP    ENDP
             END
```

```
.data
outfile             db    'sft_wins.inc',0

wind ws             label byte

; window macro format is :
;      input_str --- label of compressed window
;      name      --- name that the application uses for the window
;      corner_x,y -- upper left corner
;      x,y       --- rows and columns of the window
top_menu     label byte
      window       top_menu_str,'top_menu',0,0,1,80
                                        ; format is w,x,y,z
                                        ; w,x = row,column of the
                                        ; upper left corner
                                        ; y,z = row,column of window
bottom_menu label byte
      window       bottom_menu_str,'bottom_menu',24,0,1,80

main_menu    label byte
      window       main_menu_str,'main_menu',7,21,11,38

start_message      label byte
      window       start_message_str,'start_message',3,23,3,35

end_message label byte
      window       end_message_str,'end_message',3,23,3,34

dial_menu    label byte
      window       dial_menu_str,'dial_menu',7,7,3,66

online_msg   label byte
      window       online_msg_str,'online_msg',0,0,1,80

outgoing_msg       label byte
      window       outgoing_msg_str,'outgoing_msg',7,25,3,27

recording_msg      label byte
      window       recording_msg_str,'recording_msg',7,25,3,30

callp_win    label byte
      window       callp_win_str,'callp_win',8,24,5,33

ttone_detect_win label  byte
      window       ttone_detect_str,'ttone_detect_win',9,24,5,33
      dw     0ffffh

      bottom_menu_str    db     attrib,05bh
                   db    ' USRob tics Softmodem (c)1989        Pate'
                   db    'nt Pending            By: R bert C. Suffern '
```

```
                db      0ffh

top_menu_str    db      attrib,05bh
                db      '│ Off Line │ 8 bits │    N  Parity   │ 1 '
                db      'Stop Bit │ Auto Answer Mode --- Voice │'
                db      0ffh

online_msg_str  db      attrib,05bh
                db      '│ On Line  │ 8 bits │    No Parity   │ 1 '
                db      'Stop Bit │ 1200 Baud Originate Mode   │'
                db      0ffh

main_menu_str   db      attrib,01bh
                db      '╔',copy,36,'╗'
                db      '║   F1 --- Data Mode',copy,17,' ║'
                db      '║   F2 --- Record a Message           ║'
                db      '║   F3 --- Play Back a Message        ║'
                db      '║   F4 --- Send a Tone',copy,15,' ║'
                db      '║   F5 --- Dial a Number              ║'
                db      '║   F6 --- Execute Call Progress      ║'
                db      '║   F7 --- Execute Touch-Tone Detect  ║'
                db      '║   F8 --- Execute Message List       ║'
                db      '║   F10 -- Exit',copy,22,' ║'
                db      '╚',copy,36,'╝'
                db      0ffh

start_message_str db    attrib,01bh
                db      '╔',copy,33,'╗'
                db      '║   Hit a Key to Begin Recording  ║'
                db      '╚',copy,33,'╝'
                db      0ffh

end_message_str db      attrib,01bh
                db      '╔',copy,32,'╗'
                db      '║   Hit a Key to Stop Recording  ║'
                db      '╚',copy,32,'╝'
                db      0ffh

dial_menu_str   db      attrib,01bh
                db      '╔',copy,64,'╗'
                db      '║   Enter Phone Number:',copy,42,' ║'
                db      '╚',copy,64,'╝'
                db      0ffh

outgoing_msg_str db     attrib,01bh
                db      '╔',copy,25,'╗'
                db      '║   Sending Your Message  ║'
                db      '╚',copy,25,'╝'
                db      0ffh
```

```
recording_msg_str db      attrib,01bh
                  db      '╔',copy,28,'╗'
                  db      '║   Rec rding Your Message   ║'
                  db      '╚',copy,28,'╝'
                  db      0ffh

callp_win_str     db      attrib,01bh
                  db      '╔',copy,31,'╗'
                  db      '║ No Filter Level:              ║'
                  db      '║ Call Progress Level:          ║'
                  db      '║ Answer Tone Level:            ║'
                  db      '╚',copy,31,'╝'
                  db      0ffh

ttone_detect_str db       attrib,01bh
                  db      '╔',copy,31,'╗'
                  db      '║ No Filter:                    ║'
                  db      '║ 697-770 Hz Filter:            ║'
                  db      '║ 1209-1336 Hz Filter:          ║'
                  db      '╚',copy,31,'╝'
                  db      0ffh


; Window output file
.data

top_menu      db      00h,00h,01h,50h
              db      0b3h,5bh,20h,5bh,4fh,5bh,66h,5bh,66h,5bh
              db      20h,5bh,4ch,5bh,69h,5bh,6eh,5bh,65h,5bh
              db      20h,5bh,0b3h,5bh,20h,5bh,38h,5bh,20h,5bh
              db      62h,5bh,69h,5bh,74h,5bh,73h,5bh,20h,5bh
              db      0b3h,5bh,20h,5bh,20h,5bh,20h,5bh,20h,5bh
              db      4eh,5bh,6fh,5bh,20h,5bh,50h,5bh,61h,5bh
              db      72h,5bh,69h,5bh,74h,5bh,79h,5bh,20h,5bh
              db      20h,5bh,20h,5bh,0b3h,5bh,20h,5bh,31h,5bh
              db      20h,5bh,53h,5bh,74h,5bh,6fh,5bh,70h,5bh
              db      20h,5bh,42h,5bh,69h,5bh,74h,5bh,20h,5bh
              db      0b3h,5bh,20h,5bh,41h,5bh,75h,5bh,74h,5bh
              db      6fh,5bh,20h,5bh,41h,5bh,6eh,5bh,73h,5bh
              db      77h,5bh,65h,5bh,72h,5bh,20h,5bh,4dh,5bh
              db      6fh,5bh,64h,5bh,65h,5bh,20h,5bh,2dh,5bh
              db      2dh,5bh,2dh,5bh,20h,5bh,56h,5bh,6fh,5bh
              db      69h,5bh,63h,5bh,65h,5bh,20h,5bh,0b3h,5bh

bottom_menu db        18h,00h,01h,50h
              db      20h,5bh,55h,5bh,53h,5bh,52h,5bh,6fh,5bh
              db      62h,5bh,6fh,5bh,74h,5bh,69h,5bh,63h,5bh
              db      73h,5bh,20h,5bh,53h,5bh,6fh,5bh,66h,5bh
              db      74h,5bh,6dh,5bh,6fh,5bh,64h,5bh,65h,5bh
              db      6dh,5bh,20h,5bh,28h,5bh,63h,5bh,29h,5bh
```

```
                db      31h,5bh,39h,5bh,38h,5bh,39h,5bh,20h,5bh
                db      20h,5bh,20h,5bh,20h,5bh,20h,5bh,20h,5bh
                db      20h,5bh,50h,5bh,61h,5bh,74h,5bh,65h,5bh
                db      6eh,5bh,74h,5bh,20h,5bh,50h,5bh,65h,5bh
                db      6eh,5bh,64h,5bh,69h,5bh,6eh,5bh,67h,5bh
                db      20h,5bh,20h,5bh,20h,5bh,20h,5bh,20h,5bh
                db      20h,5bh,20h,5bh,20h,5bh,42h,5bh,79h,5bh
                db      3ah,5bh,20h,5bh,52h,5bh,6fh,5bh,62h,5bh
                db      65h,5bh,72h,5bh,74h,5bh,20h,5bh,43h,5bh
                db      2eh,5bh,20h,5bh,53h,5bh,75h,5bh,66h,5bh
                db      66h,5bh,65h,5bh,72h,5bh,6eh,5bh,20h,5bh

main_menu       db      07h,15h,0bh,26h
                db      0c9h,1bh,0cdh,1bh,0cdh,1bh,0cdh,1bh,0cdh,1bh
                db      0cdh,1bh,0cdh,1bh,0cdh,1bh,0cdh,1bh,0cdh,1bh
                db      0cdh,1bh,0cdh,1bh,0cdh,1bh,0cdh,1bh,0cdh,1bh
                db      0cdh,1bh,0cdh,1bh,0cdh,1bh,0cdh,1bh,0cdh,1bh
                db      0cdh,1bh,0cdh,1bh,0cdh,1bh,0cdh,1bh,0cdh,1bh
                db      0cdh,1bh,0cdh,1bh,0cdh,1bh,0cdh,1bh,0cdh,1bh
                db      0cdh,1bh,0cdh,1bh,0cdh,1bh,0cdh,1bh,0cdh,1bh
                db      0cdh,1bh,0cdh,1bh,0bbh,1bh,0bah,1bh,20h,1bh
                db      20h,1bh,20h,1bh,46h,1bh,31h,1bh,20h,1bh
                db      2dh,1bh,2dh,1bh,2dh,1bh,20h,1bh,44h,1bh
                db      61h,1bh,74h,1bh,61h,1bh,20h,1bh,4dh,1bh
                db      6fh,1bh,64h,1bh,65h,1bh,20h,1bh,20h,1bh
                db      20h,1bh,20h,1bh,20h,1bh,20h,1bh,20h,1bh
                db      20h,1bh,20h,1bh,20h,1bh,20h,1bh,20h,1bh
                db      20h,1bh,20h,1bh,20h,1bh,20h,1bh,20h,1bh
                db      0bah,1bh,0bah,1bh,20h,1bh,20h,1bh,20h,1bh
                db      46h,1bh,32h,1bh,20h,1bh,2dh,1bh,2dh,1bh
                db      2dh,1bh,20h,1bh,52h,1bh,65h,1bh,63h,1bh
                db      6fh,1bh,72h,1bh,64h,1bh,20h,1bh,61h,1bh
                db      20h,1bh,4dh,1bh,65h,1bh,73h,1bh,73h,1bh
                db      61h,1bh,67h,1bh,65h,1bh,20h,1bh,20h,1bh
                db      20h,1bh,20h,1bh,20h,1bh,20h,1bh,20h,1bh
                db      20h,1bh,20h,1bh,20h,1bh,0bah,1bh,0bah,1bh
                db      20h,1bh,20h,1bh,20h,1bh,46h,1bh,33h,1bh
                db      20h,1bh,2dh,1bh,2dh,1bh,2dh,1bh,20h,1bh
                db      50h,1bh,6ch,1bh,61h,1bh,79h,1bh,20h,1bh
                db      42h,1bh,61h,1bh,63h,1bh,6bh,1bh,20h,1bh
                db      61h,1bh,20h,1bh,4dh,1bh,65h,1bh,73h,1bh
                db      73h,1bh,61h,1bh,67h,1bh,65h,1bh,20h,1bh
                db      20h,1bh,20h,1bh,20h,1bh,20h,1bh,20h,1bh
                db      20h,1bh,0bah,1bh,0bah,1bh,20h,1bh,20h,1bh
                db      20h,1bh,46h,1bh,34h,1bh,20h,1bh,2dh,1bh
                db      2dh,1bh,2dh,1bh,20h,1bh,53h,1bh,65h,1bh
                db      6eh,1bh,64h,1bh,20h,1bh,61h,1bh,20h,1bh
                db      54h,1bh,6fh,1bh,6eh,1bh,65h,1bh,20h,1bh
                db      20h,1bh,20h,1bh,20h,1bh,20h,1bh,20h,1bh
                db      20h,1bh,20h,1bh,20h,1bh,20h,1bh,20h,1bh
```

```
        db      20h,1bh,20h,1bh,20h,1bh,20h,1bh,0bah,1bh
        db      0bah,1bh,20h,1bh,20h,1bh,20h,1bh,46h,1bh
        db      35h,1bh,20h,1bh,2dh,1bh,2dh,1bh,2dh,1bh
        db      20h,1bh,44h,1bh,69h,1bh,61h,1bh,6ch,1bh
        db      20h,1bh,61h,1bh,20h,1bh,4eh,1bh,75h,1bh
        db      6dh,1bh,62h,1bh,65h,1bh,72h,1bh,20h,1bh
        db      20h,1bh,20h,1bh,20h,1bh,20h,1bh,20h,1bh
        db      20h,1bh,20h,1bh,20h,1bh,20h,1bh,20h,1bh
        db      20h,1bh,20h,1bh,0bah,1bh,0bah,1bh,20h,1bh
        db      20h,1bh,20h,1bh,46h,1bh,36h,1bh,20h,1bh
        db      2dh,1bh,2dh,1bh,2dh,1bh,20h,1bh,45h,1bh
        db      78h,1bh,65h,1bh,63h,1bh,75h,1bh,74h,1bh
        db      65h,1bh,20h,1bh,43h,1bh,61h,1bh,6ch,1bh
        db      6ch,1bh,20h,1bh,50h,1bh,72h,1bh,6fh,1bh
        db      67h,1bh,72h,1bh,65h,1bh,73h,1bh,73h,1bh
        db      20h,1bh,20h,1bh,20h,1bh,20h,1bh,20h,1bh
        db      0bah,1bh,0bah,1bh,20h,1bh,20h,1bh,20h,1bh
        db      46h,1bh,37h,1bh,20h,1bh,2dh,1bh,2dh,1bh
        db      2dh,1bh,20h,1bh,45h,1bh,78h,1bh,65h,1bh
        db      63h,1bh,75h,1bh,74h,1bh,65h,1bh,20h,1bh
        db      54h,1bh,6fh,1bh,75h,1bh,63h,1bh,68h,1bh
        db      2dh,1bh,54h,1bh,6fh,1bh,6eh,1bh,65h,1bh
        db      20h,1bh,44h,1bh,65h,1bh,74h,1bh,65h,1bh
        db      63h,1bh,74h,1bh,20h,1bh,0bah,1bh,0bah,1bh
        db      20h,1bh,20h,1bh,20h,1bh,46h,1bh,38h,1bh
        db      20h,1bh,2dh,1bh,2dh,1bh,2dh,1bh,20h,1bh
        db      45h,1bh,78h,1bh,65h,1bh,63h,1bh,75h,1bh
        db      74h,1bh,65h,1bh,20h,1bh,4dh,1bh,65h,1bh
        db      73h,1bh,73h,1bh,61h,1bh,67h,1bh,65h,1bh
        db      20h,1bh,4ch,1bh,69h,1bh,73h,1bh,74h,1bh
        db      20h,1bh,20h,1bh,20h,1bh,20h,1bh,20h,1bh
        db      20h,1bh,0bah,1bh,0bah,1bh,20h,1bh,20h,1bh
        db      20h,1bh,46h,1bh,31h,1bh,30h,1bh,20h,1bh
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.286
.model small
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
;      Screen driver routines
;
;      This routine writes the receive data to the screen during terminal
;      mode.
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%

      include      equates

      public       init_comm_screen,save_screen,restore_screen
      public       screen_out,print_parity

      extrn window_up:near

      extrn display_segment:word,main_flags:word

      extrn online_msg:byte

.data
      screen_buffer      dw     2000 dup(?)
      cursor             dw     ?
      buffer_pos   dw     ?
      out_char     db     ?

      parity_msg   db     '8   No'
                   db     '      '
                   db     '      '
                   db     '      '
                   db     '7 Even'
                   db     '7  Odd'
                   db     '7Space'
                   db     '7 Mark'
.code
```

```
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
INIT_COMM_SCREEN  PROC  NEAR

      lea   si,online_msg
      call  window_up
      call  print_parity

      mov   cursor,100h
      mov   buffer_pos,160
; position the cursor
      mov   dx,cursor
      mov   ah,02
      xor   bh,bh
      int   10h

      mov   es,display_segment
      mov   di,160
      mov   cx,(23*80)
      mov   ax,0720h          ; attribute and ' '
      cmp   display_segment,mono
      je    no_color
      mov   ax,1f20h          ; attribute and ' '
no_color:
      rep   stosw

      call  save_screen

      ret

INIT_COMM_SCREEN  ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
SAVE_SCREEN PROC  NEAR
.data
      cursor_pos  dw    ?
.code
      mov   cx,2000
      lea   di,screen_buffer
      xor   si,si
      mov   ax,display_segment
      push  ds
      pop   es
      push  ds
      mov   ds,ax
      rep   movsw
      pop   ds

```

```
     mov   ah,03
     xor   bh,bh
     int   10h
     m v   cursor_pos,dx

     ret

SAVE_SCREEN ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
RESTORE_SCREEN    PROC   NEAR

     mov   cx,2000
     lea   si,screen_buffer
     mov   es,display_segment
     xor   di,di
     rep   movsw

     mov   ah,02h
     xor   bh,bh
     mov   dx,cursor_pos
     int   10h

     ret

RESTORE_SCREEN    ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
SCREEN_OUT  PROC  NEAR
; AL has the character to print to the screen   0 to 7fh
     cmp   al,' '
     jae   out_it
     cmp   al,cr
     jne   chk_lf

; carriage return
     mov   dx,cursor
     xor   dl,dl
     mov   al,dh
     mov   cl,160
     mul   cl
     mov   buffer_pos,ax
     jmp   no_wrap

chk_lf:
     cmp   al,lf
     jne   chk_bs
```

```
        mov     dx,cursor
        cmp     dh,23
        j       scroll_it
        inc     dh
        add     buffer_p s,160
        jmp     no_wrap

chk_bs:
        cmp     al,bs
        je      do_bs
        ret
do_bs:
        cmp     buffer_pos,160
        jne     no_top
        ret
no_top:
        sub     buffer_pos,2
        mov     di,buffer_pos
        mov     al,' '
        push    es
        mov     es,display_segment
        mov     es:[di],al
        pop     es

        mov     dx,cursor
        dec     dl
        jns     no_wrap
        mov     dl,79
        dec     dh
        jmp     short no_wrap
out_it:
        push    es
        mov     es,display_segment
        mov     di,buffer_pos
        stosb
        inc     di
        mov     buffer_pos,di
        pop     es

        mov     dx,cursor
        inc     dl
        cmp     dl,80
        jne     no_wrap
        inc     dh
        cmp     dh,24
        jne     no_scroll

        m v     buffer_pos,( 23 * 160 )
        mov     dx,1700h
scroll_it:
```

```
        mov   di,160
        mov   si,320
        mov   cx,22*80
        mov   ax,display_segment

        push  es
        push  ds
        mov   ds,ax
        mov   es,ax
        rep   movsw
        pop   ds

        mov   cx,80
        mov   al,' '
clear_line:
        stosb
        inc   di
        loop  clear_line
        pop   es

        jmp   short no_wrap
no_scroll:
        xor   dl,dl

; get new buffer position
        mov   al,dh
        mov   cl,160
        mul   cl
        mov   buffer_pos,ax

no_wrap:
        mov   cursor,dx
        xor   bh,bh
        mov   ah,02
        int   10h

        ret

SCREEN_OUT  ENDP
;
;%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
;
PRINT_PARITY      PROC  NEAR

        mov   ax,main_flags
        mov   al,ah
        and   ax,07h
        mov   bl,6
        imul  bl
        mov   bx,ax
```

```
        mov   es,display_s gment             ; print word length
        mov   di,26
        mov   al,parity_msg[bx]
        inc   bx
        stosb

        mov   cx,5
        mov   di,44
out_loop:
        mov   al,parity_msg[bx]
        stosb
        inc   di
        inc   bx
        loop  out_loop

        mov   di,70
        mov   ax,5b20h
        mov   [es:di],ax

        ret


PRINT_PARITY      ENDP
        END


; general equates

; conditional assembly
        board equ   0
        modem_board       equ   35ch

        buf_len     equ   8192 * 2          ; TX and RX buffers
        rx_samples_length equ   8192 * 2    ; byte size

        mono  equ   0b000h
        color_seg equ     0b800h

        b0    equ   1
        b1    equ   2
        b2    equ   4
        b3    equ   8
        b4    equ   10h
        b5    equ   20h
        b6    equ   40h
        b7    equ   80h
        b8    equ   100h
        b9    equ   200h
        b10   equ   400h
        b11   equ   800h
```

```
b12     equ     1000h
b13     equ     2000h
b14     equ     4000h
b15     equ     8000h

cr      equ     13
lf      equ     10
bs      equ     8

F1      equ     3b00h
F2      equ     3c00h
F3      equ     3d00h
F4      equ     3e00h
F5      equ     3f00h
F6      equ     4000h
F7      equ     4100h
F8      equ     4200h
F9      equ     4300h
F10     equ     4400h

ALT_A equ       1e00h
ALT_H equ       2300h
ALT_P equ       1900h
ALT_S equ       1f00h


UP_ARROW equ        4800h
DOWN_ARROW equ      5000h

; DMA channels 5 and 6 equates
        dma_5_page    equ    8bh
        dma_6_page    equ    89h

        dma_5_address       equ    0c4h
        dma_5_count equ     0c6h

        dma_6_address       equ    0c8h
        dma_6_count equ     0cah

        rd_status     equ    0d0h
        rd_temp             equ    0dah

        wr_cmd              equ    0d0h
        wr_req              equ    0d2h
        wr_single_mask      equ    0d4h
        wr_mode             equ    0d6h
        wr_clr_byte_ptr     equ    0d8h
        wr_master_clr       equ    0dah
        wr_clr_mask equ     0dch
        wr_all_mask equ     0deh
```

```
tone_2225     equ     15189          ; 2 * freq / 9600
tone_2225_72s       equ     20252

tone_1500     equ     10240

1941   equ    6424
1852   equ    5816
1770   equ    5257
1697   equ    4758

h1663 equu    11148
h1477 equ    10083
h1336 equ    9120
h1209 equ    8253

1941_72s      equ     8565
1852_72s      equ     7755
1770_72s      equ     7009
1697_72s      equ     6344

h1663_72s     equ     14864
h1477_72s     equ     13444
h1336_72s     equ     12160
h1209_72s     equ     11004
```

END OF ASSEMBLY LANGUAGE LISTING